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MACHINERY

February, 1911

MACHINE TOOL TESTING

A METHOD OF TESTING AND INSPECTING VERTICAL BORING MILLS AT THE BULLARD MACHINE TOOL CO.'S SHOPS

By ERIK OBERG*

MECHANICS engaged in the building of machine tools are, in general, quite familiar with the methods ordinarily used for testing the alignment and truth of ways, spindles, shafts, tables, etc., as ordinarily carried out in machine tool building plants. Some of these methods have been described and illustrated in previous issues of MACHINERY. (See MACHINERY, November, 1909, "Assembling a 24-inch Engine Lathe"; December, 1909, and January, 1910, "Assembling a 48-inch Motor-Driven Planer.") Well-defined methods for a final running test, carried out systematically and with a view of detecting and eliminating all possible defects in the machine before shipping, are, however, not in vogue in machine tool building plants in general. For this reason a description of the system used for this purpose at the Bullard Machine Tool Co.'s shops at Bridgeport, Conn., will be of especial interest to all concerned with machine building in general, and especially to machine tool builders and users.

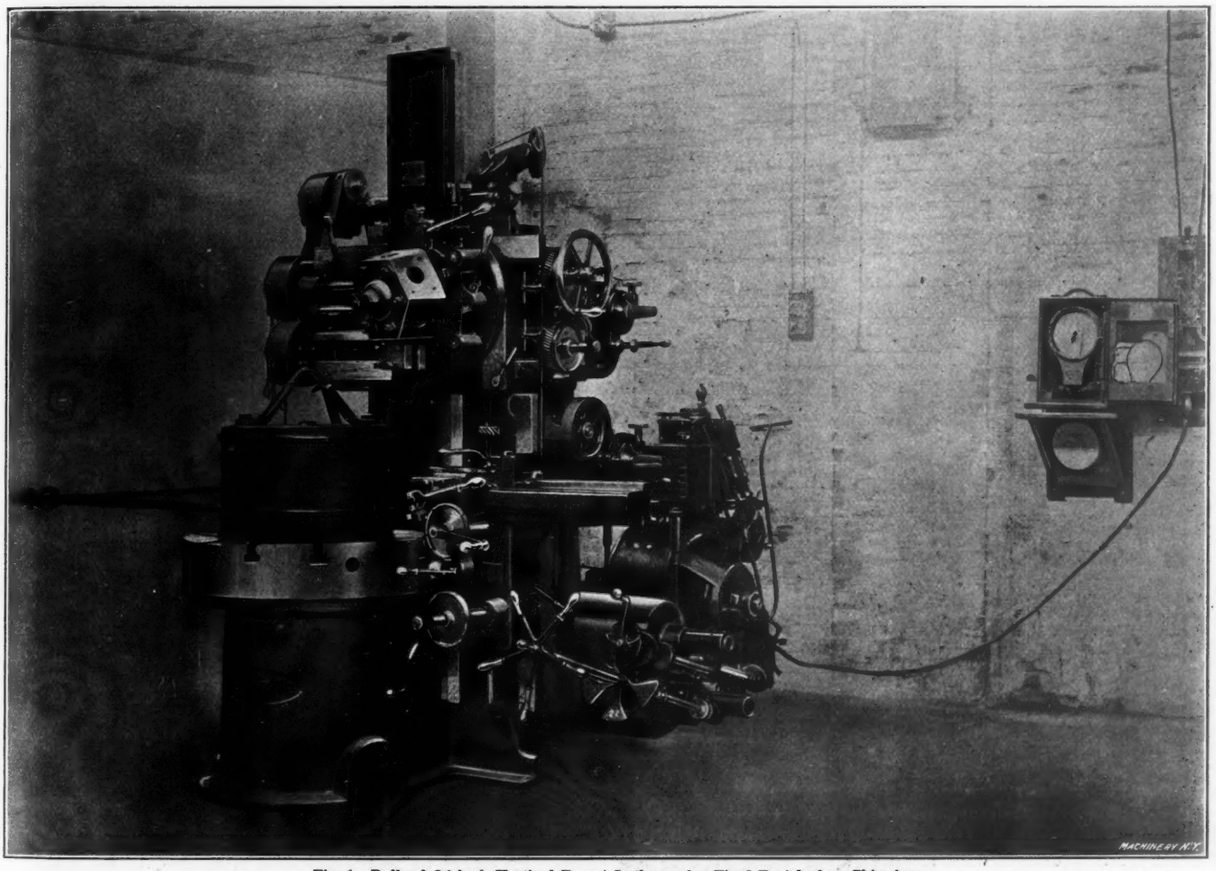

Fig. 1. Bullard 24-inch Vertical Turret Lathe under Final Test before Shipping

The boring mills and vertical turret lathes built by the Bullard Machine Tool Co. are all made according to the unit system of construction, that is, each of the devices of which the complete machine is made up is self-contained, being built and assembled as units, all these units being then finally assembled at one time on the frame of the machine proper. The unit system of construction admirably lends itself to the plan of testing put into use in these shops. In fact, if such a system of building the machines were not used, some of the preliminary tests now carried out would be impossible.

Briefly described, the testing system consists of first testing the running and power transmission qualities of each of the individual units that go to make up the machine, dynamometer tests being made on the most important parts, and then, when all the units are assembled and the machine is ready for shipment, it is again subjected to a final test and inspection, while running idle as well as while under load. Suitable instruments are used in the test to record definitely the conditions to be determined. Besides these tests, the machines are subjected to the regular tests for alignment, etc. and rigid inspection of both the individual parts and the assembled machine, the same as in any well conducted machine tool shop.

Testing the Driving Speed Box

In Fig. 3 is shown the arrangement for testing the running qualities of the power transmission gears in the main speed box through which the power to the machine is delivered. The speed box is mounted on a frame and support as indicated, and power is transmitted to it by means of a belt pulley on the end of the regular driving shaft. The dynamometer is then so arranged that the power delivered from the shaft which afterwards furnishes the power to the machine itself, is measured. In this way the conditions to which the speed box is subjected during the test are exactly the same as those

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to which it will be subjected when assembled on the machine

There are five speed changes in the gear box and each of the sets of gears is subjected to a load test corresponding to a delivery of 15 H.P. The adjustment for measuring the power at the various speeds is very simply taken care of by means of a standard lever-arm and weight, as indicated in the illustration, the lever-arm being provided with five eye bolts at carefully pre-determined locations, to which the weight is successively attached by a hook as shown. This simple arrangement makes it possible to test the power output at the various speeds very quickly. As 15 H.P. is an output much greater than that to which the machine is ever likely to be subjected while in actual operation, any defect in the gears of whatever kind would be likely to show itself at this time. Any defects in alignment causing heating or binding, and any defects in the gears producing excessive noise, are easily detected at this time and remedied before the gear box is assembled on the machine.

Testing the Feed Gear Boxes, Power Traverse Gear, etc.

In Fig. 2 are shown a number of the minor gear boxes and mechanisms set up for testing. Some are mounted on special brackets and others directly on plates screwed to the bench. Each part is provided with an individual pulley and driven from overhead shafts. During the tests of these minor details, no actual dynamometer test is made, but each of the parts is running under a load obtained by clamps firmly secured to the ends of the shafts, these clamps being prevented from rotating by resting one end against the bench. This arrangement is seen in three instances on the illustration. The parts are permitted to run in this way for about an hour, during which time the inspector is watching their performance, looking out for any undue noises of the gears, heating of the bearings and shafts, or any other defects. All defects found at this time are remedied, and the units do not pass through this stage of the testing before they are running in a satisfactory manner.

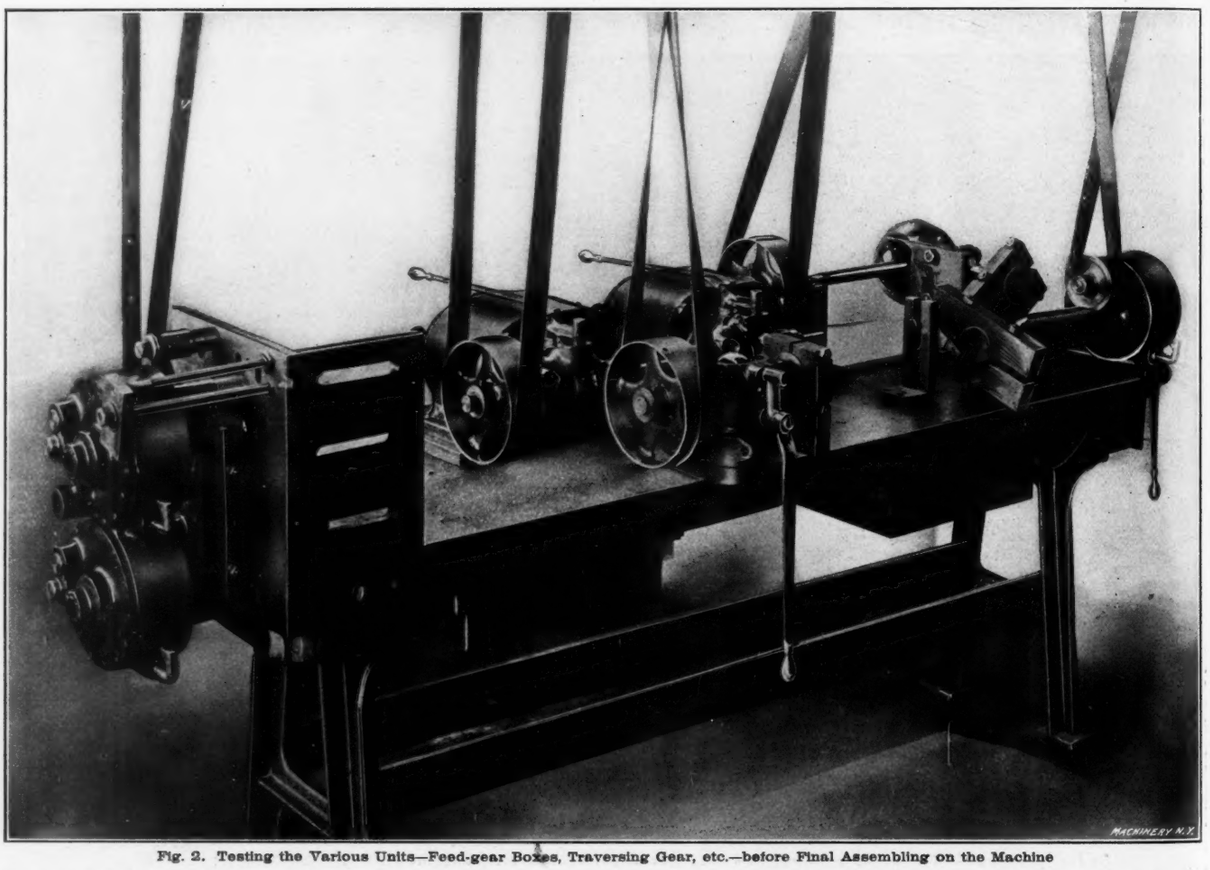

Fig. 2. Testing the Various Units—Feed-gear Boxes, Traversing Gear, etc.—before Final Assembling on the Machine

Testing the Complete Machine

The most interesting part of the tests to which the machines are subjected, however, yet remains to be described. This test takes place when the machine is finally assembled and has passed the ordinary inspection tests on the assembling floor. Under ordinary conditions, in fact, we would say that the machine is ready to ship, and in a great many machine shops the machines *are* shipped at this stage. The experience of the Bullard Machine Tool Co., however, indicates that the final test to which they subject their machines often is a means for detecting defects which would have passed through all previous stages of inspection, and which, in fact, no other method of inspection would make it possible to detect. These are the defects which ordinarily are found first when the machine is mounted and set to work in the shops of a customer, and which cause a great deal of expense, worry and difficulty—both directly and indirectly. By subjecting the machines to this final test before shipping, nearly all these minor defects—defects which in some shops are considered as absolutely unavoidable—are in the majority of cases remedied before the machine leaves the builders' plant.

During this last test, the machine is driven by an electric motor belted to the driving pulley of the machine, a watt-meter being connected to the motor so that the load on the motor is carefully recorded. The machine set up for the final test, the motor by which it is driven, and the watt-meter are shown in Fig. 1. On the table of the machine is mounted a friction disk brake by means of which the load is applied to the machine, one set of the disks of this brake being held stationary and the other revolving with the table. The friction brake can be adjusted to whatever resistance is required.

The test proper is divided into three stages: First the machine is run idle for one hour; then load is applied during another hour's run; and finally the machine is again run idle for a third hour, except that at this time all the feed motions, traverse motions, reversing gears, etc., are set into action. During the whole of this test an inspector who is entirely independent of the shop and who has had nothing whatever to do with the machine until it passes to him for its final inspection, takes note of the behavior of all of the working parts of the machine. A most interesting feature of the test is the record made of the temperature of the bearings. Thermometers are submerged in the oil wells of all the important bearings and it has been found that this temperature test of the bearings is the only possible means for detecting slight

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defects in the alignment of shafts, causing in some instances a very small—yet objectionable—binding action and consequent heating of the bearings. A temperature, under load, of 110 degrees F.—rapidly rising in some cases—has been found to indicate trouble, the difficulty being almost always due to mis aligned bearings. Any temperature over 95 to 100 degrees is carefully watched, and the test prolonged to allow a thorough observation of the part in question.

While the inspection system in the shop proper, covering the individual parts of the machine when in process of manufacture, is as rigid as it can possibly be made, a great many

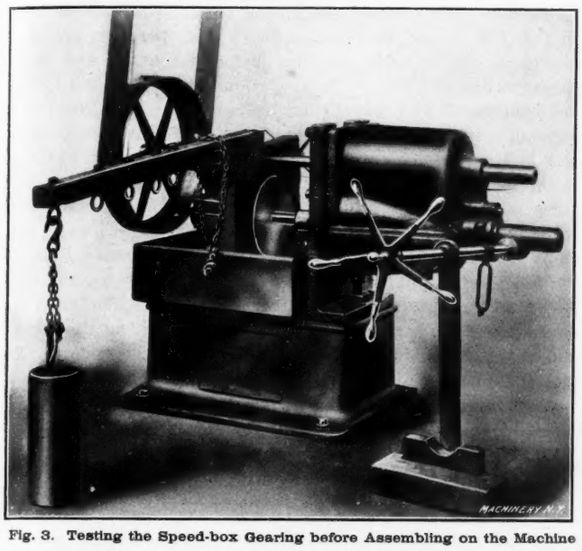

Fig. 3. Testing the Speed-box Gearing before Assembling on the Machine

minor defects in adjustments and some omissions are detected and remedied during this final inspection. The fact that the inspector is entirely removed from the shop proper and is responsible to no one but the superintendent is an important feature of this system of inspection, as, of course, the personal factor in any inspection system of this kind is a most important consideration. The inspector must actually look for defects, and have no hesitancy in putting them on record; otherwise the system would be of little value.

In Fig. 4 is shown a chart made on a Bristol's recording

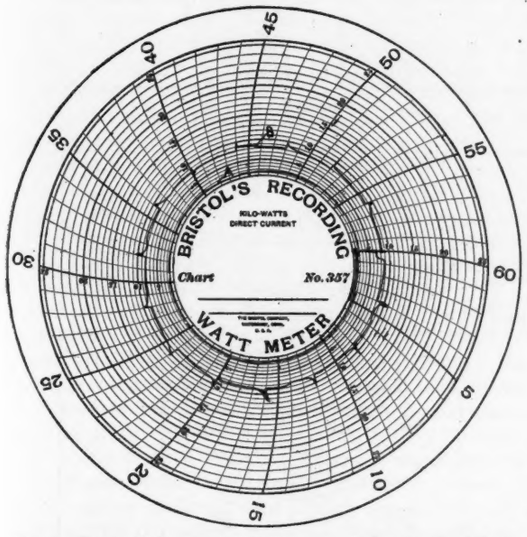

Fig. 4. Chart obtained on the Watt-meter during the Final Test

watt-meter which gives the record obtained when running the machine idle and under load, the line *A*, nearest the center, showing the first hour's test, with the machine running with no load. The outside line *B* shows the record of the test during the second hour, when the machine was running under full load. The breaks or peaks in the record curve indicate the moments when the speed changes were made and the absorption disk brake adjusted for the new speed conditions.

Ordinarily three charts are made, one for each hour's test, but in the present case the records have all been made on the same chart in order to show comprehensively how the test is made. The third hour's test covers that of the first hour, so that only one line is shown for both these tests. The report made by the inspector includes three of these charts, a temperature record for the bearings, and a list of the defects found. The inspector's report, for example, would have the appearance as shown below:

Inspector's Report of Final Test of 24-inch Vertical Turret Lathe

Bearings	Temperature, Degrees F. First Hour, Light	Second Hour, Load	Third Hour, Light
Speedbox Bearings	70	88	85
Headstock Bearings	65	68	68
Table Pinion Bearing	76	79	80
Power Traversing Bracket, Upper	68	71	72
Power Traversing Bracket, Lower	70	74	74
Feed Works, Upper	66	68	68
Feed Works, Lower	65	69	69
Driving Pulley Bracket	70	80	78

Remarks

Headstock: Oil level set too high. (Reset).
Speedbox leaked. (Return hole drilled).
Observation stops Nos. 4 and 5 bad. (Replaced).
Feed-worm bottomed in upper gear. (Stop adjusted).
Side-head turret bound on stud when filled with tools. (Hole relieved).
Instruction plate on speed box missing. (Attached).
Chuck-jaw binder bolts bottomed in T-slots. (Shortened).
Two securing-screws loose in table gear. (Replaced).
(Signed) Olsen—Inspector.

The items under the head of "Remarks" which are in parentheses, indicates what means have been taken to remedy the defect. At the time when the machine has passed out of the inspector's hands, there is little likelihood that any defect of a serious nature will ever be detected after the machine has been installed in the shop of a customer.

The Bullard Machine Tool Co. believes that this system of protecting both itself and the customer against the annoyances of small imperfections is unique. The system shows an appreciation on the part of the company of the importance of guarding against the unfavorable influence caused by small and comparatively unimportant details being overlooked. These, in the long run, have a most important effect on the reputation of a firm as regards the care with which the machinery is built and the final inspection carried out.

* * *

COPPER-CLAD STEEL

As a result of a number of attempts to produce steel with a copper coating which could be of any desired thickness and in which the two metals could be so securely welded together as to be amenable to any of the usual methods of metal working without destroying the integrity of the weld, a method of thus treating steel has been developed according to the *Journal of Industrial Engineering and Chemistry*. In this process the steel is rolled into short round billets which are sand-blasted and pickled to remove the scale. The billet is brought to red heat in a pre-heater, and then immersed in a copper bath which is in a supermolten condition, and forms an alloy film on the billet. The billet is then centered in a tube mold and commercially pure molten copper poured in around it. This forms a uniform shell which is allowed to harden. The copper clad billet thus formed is removed from the mold and after a washing heat, is rolled to the size desired, the proportional areas of the copper and steel remaining practically constant for all sizes. The tensile strength of this copper clad steel is equal to, if not greater than the steel which has been thus treated.

* * *

The composition of babbitt metals as specified by the Bureau of Steam Engineering of the United States Navy, should be 88.8 per cent banca tin, 7.5 per cent antimony, and 3.7 per cent copper. The metals should be well fluxed with resin and borax in mixing.

PUNCHES AND DIES FOR MAKING A SPRING CLIP

By DAYTON

The following article describes an interesting set of punches and dies for making a spring clip which is attached to a leather typewriter carrying case. These punches and dies were designed in a shop where the writer was formerly em-

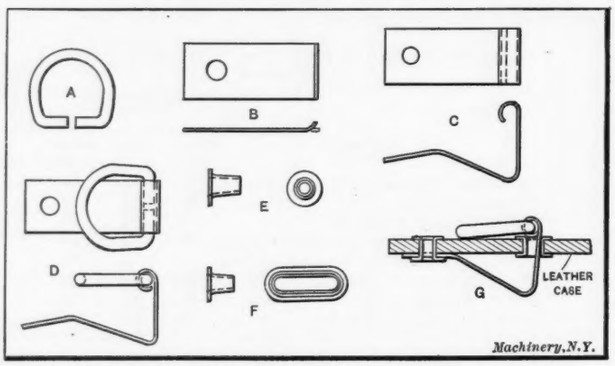

Fig. 1. View showing the Various Operations on a Spring Clip used on a Leather Carrying Case for a Typewriter

ployed, and were used for performing the various operations on the pieces shown in Fig. 1. It may be mentioned that these tools have been in continual use for over two years, and notwithstanding the fact that they were somewhat in the nature of an experiment they have proved to be all that was expected of them.

The various operations on this spring clip are illustrated in Fig. 1. The piece *A* is a ring made from soft-steel wire, which is cut off and bent in one operation. At *B* is shown the flat spring after the first operation, where it is pierced, cut off and slightly bent. The curling and bending operation on this spring is shown at *C*. Here the spring is bent and a three-quarter curl given to it. At *D* is shown the spring and ring assembled. *E* and *F* are the hollow rivets or eyelets, which are used. *E* is used for fastening the spring clip to the leather carrying case, and *F* is used as a guide, through which the spring operates. At *G* is shown the spring clip complete, and attached to the case. Here the spring clip is fastened to the carrying case by the hollow rivet *E*, and the hollow rivet *F* is riveted over the case and acts as a guide.

The first operation on this spring clip, is the making of the ring *A*, Fig. 1, and the dies for doing this operation are shown in Fig. 2. In this die the wire is fed in, cut off and bent at one stroke of the press. In operation, the wire is fed through the bushing *A* and up against the stop *B*. The hole in the bushing *A* is tapered, and the stock passes freely through it, except at the extreme inner end where it is made the same size as the stock. After the stock is inserted in the bushing *A* the press is tripped, and as the punch *C* descends, the shoulder *D* rests on the stripper-plate *E*. On the further downward movement of the ram, the punch *C* ascends into the space *F* against the tension of the spring *G*. This spring *G* returns the punch to its normal position on the return stroke. Ths cam *H* is set to act just after the punch *C* is in position on the stripper and moves the blade *I* which is fastened to the slide *J*. This plate or former *I* also cuts off the stock, performing this operation at the point *K* where the bushing *A* is hardened so that

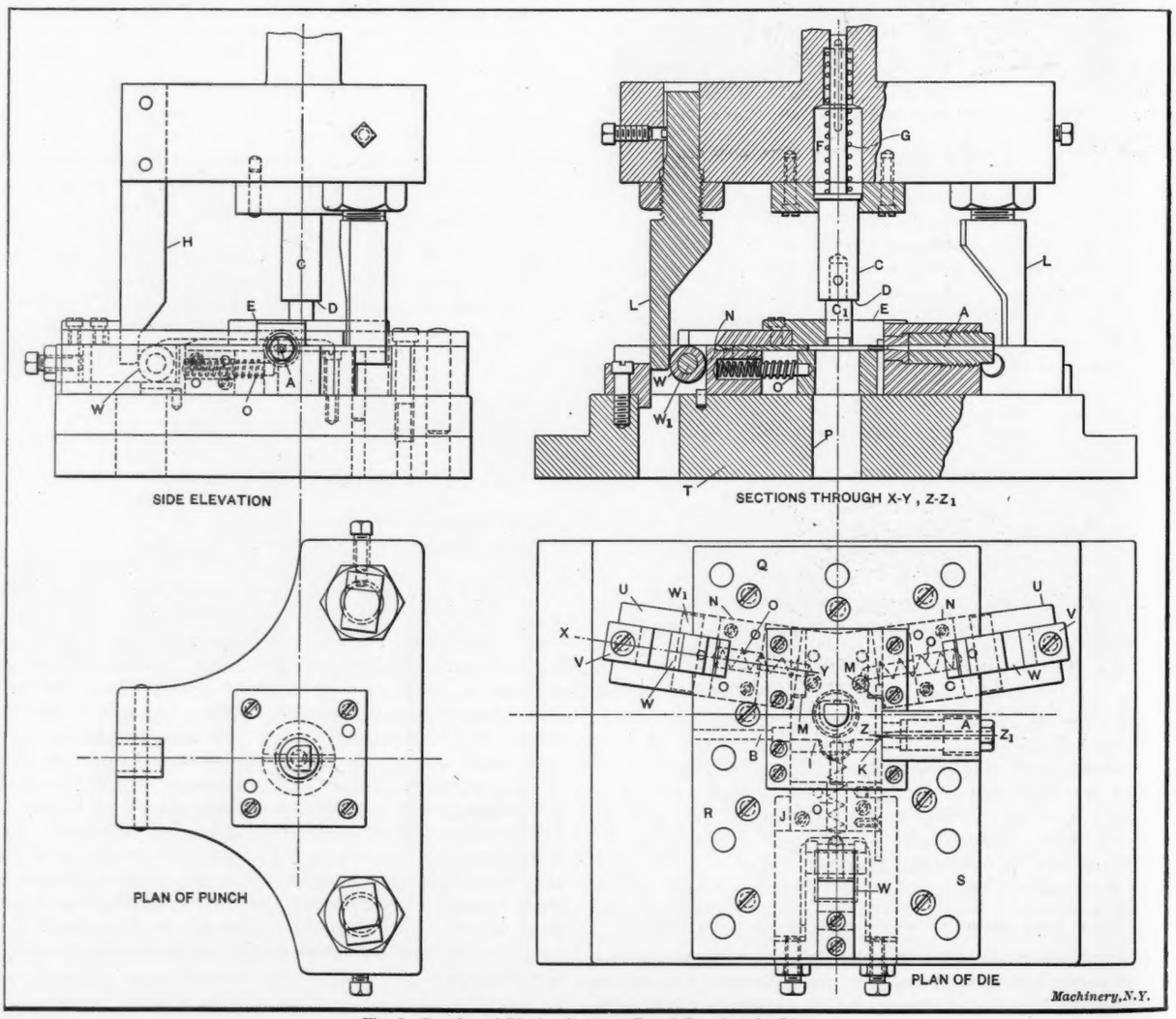

Fig. 2. Punch and Die for Cutting off and Forming the Ring

it acts as a shear. As the ram of the press descends still further, this former *I* is forced in and bends the stock around the lower end of the punch C_1.

The former *I* is actuated by the cam *H*, which presses

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against the roll *W* attached to the slide *J*. The slide *J* now remains stationary because of the straight portion of the cam *H*, and on the further descent of the ram the cams *L* come into operation on the slides *N* which are attached to each side of the die. These slides work in unison and carry formers *M* which bend the stock around the punch C_1. The slides *N* work in the holders *U*, and have rollers *W* attached to them. All the rollers *W* are pivoted on studs W_1. This completes the forming of the ring, and on the upward stroke

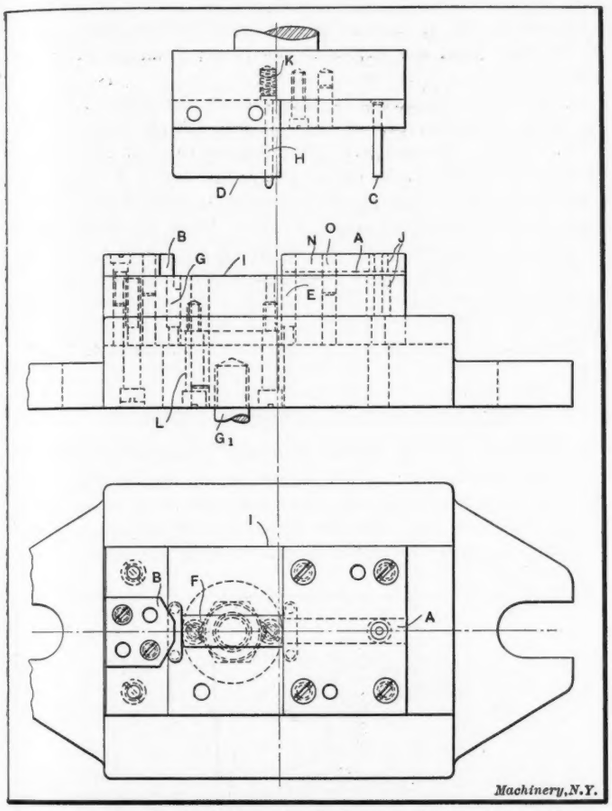


Fig. 3. Punch and Die for Cutting off and giving the First Bend to the Spring

of the press, cams *L* and *H* release the forming members which are returned to their normal positions by means of the various helical springs *O*. When the punch *C* rises, the completed ring is stripped by the stripper *E* and falls through the hole *P* cut in the base, into a basket. The feeding of this die is continuous, and as the trip can be held down until the stock is exhausted, the production is very rapid.

The guide-blocks *Q*, *R* and *S* are fastened to the base *T* and serve to guide the slides *J* and *N* in their travel. The slides *N* consist of the slotted pieces *U*, which slide between guides *Q*, *R* and *S*, and are also guided by blocks *V*. A keyway is cut in the punch *C*, in which a pin operates to prevent it from turning against the action of the forming slides.

The next step in making this spring clip is the cutting off and the forming of the first bend in the spring *B*, Fig. 1. The punch and die used for this operation are shown in Fig. 3. The stock is fed through the channel *A* against the stop *B*, and is pierced by the punch *C*. The punch *D* cuts the strip off, and also gives it a slight curl. The blade *E* and former *G* are set in the die, the blade *E* acting as a shear for cutting off the stock, and the blade *G* acting as the lower former. The blade *E* is carried down into the die on the pad *F* until the end of the stroke is reached, when the blank is curled on the former *G*.

As the hole is not blanked in the first step it is necessary that the pilot *H* should retreat. Provision is made for this by drilling a hole in the punch-holder, and making a shoulder on the punch. A spring *K* is set in the holder, behind the pilot *H*, which allows the latter to ascend when it strikes a strip without a hole, and forces it out when a hole has been blanked in the strip. This pilot *H* locates the blank in the correct position in the nest by engaging with the pierced hole, thus preventing the blank from slipping in the curling operation.

It will be noticed that the die proper is made up of several separate pieces, which are fitted to the main block *I*, the latter being made from tool steel. The piercing punch *C* works in a hardened bushing *J*. The blade *E* and former *G* are separate pieces and are hardened and ground. This permits them to be easily removed in case they break or other repairs are necessary. The pad *F* descends far enough for the curling operation to be completed when the punch *D* bears against it. A stiff spring, not shown, is fastened by the stud *G*, underneath the press, which actuates the pad *F*. The other details of this punch and die can be clearly understood from the illustration.

The spring is now ready for the second operation, that is, the complete forming and making of the three-quarter curl. This operation is done in the sub-press die shown in Fig. 4. The base *A* and plunger *B* of this sub-press are made from cast iron and are lined up with each other by the guide-pins *C*, as shown. These guide-pins are placed at the rear of the die, so as to facilitate its operation. The spring which is now in the form shown at *B*, Fig. 1, is placed in the nest in the carrier *F*, located at the front of the die. The carrier is then shoved into position by hand, and the spring located by the gage-plates *D* and *E*. After the spring is in this position the carrier *F* is returned to the front of the die by the spring *G*.

In operation, the punch *H* descends and forms the spring on the die *I*. The action of the punch *H* forces the work up in a perpendicular position between the face *L* of the pad *O* and face *K* of the punch. As the punch continues in its downward movement, the work passes up between the faces *K* and *J* on the punch, and is curled around in the circular former in punch *N*. The plate K_1 prevents the curl of the spring being

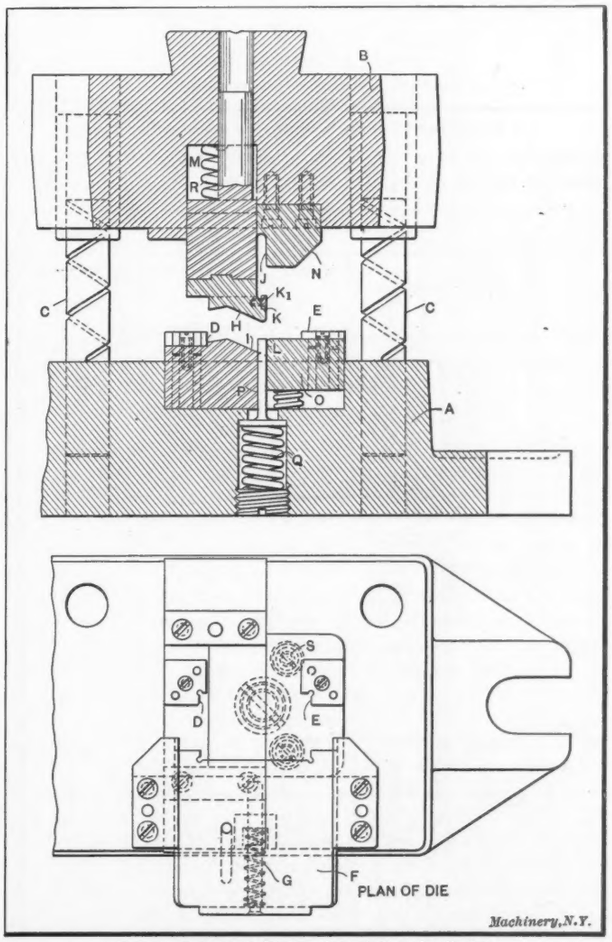


Fig. 4. Sub-press Die for Completing the Spring

completely closed. While the spring is being formed the punch *H* ascends into the space *M*, and after the bending operation is completed, the punch is returned to its former position by means of the spring *R*. In making the three-quarter curl the punch *N* forces pad *O* and plunger *P* down into the die,

these latter being returned by helical springs *S* and *Q* respectively, as shown. This plunger *P* acts as an ejector and forces the spring out of the die when the punch ascends.

The next operation on the spring clip is the closing of the

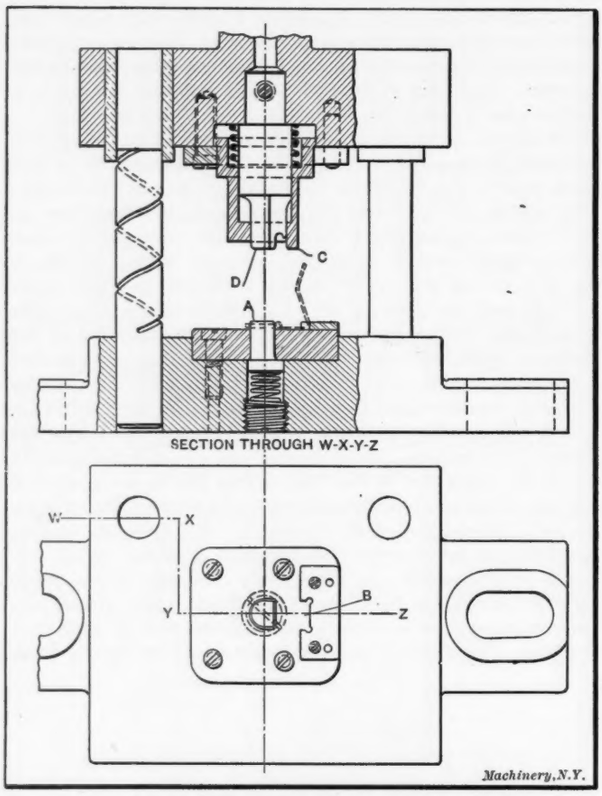


Fig. 5. Sub-press Die for Fastening the Spring to the Ring

spring over the ring. This operation is completed in the sub-press die shown in Fig. 5. In operation the spring is hooked

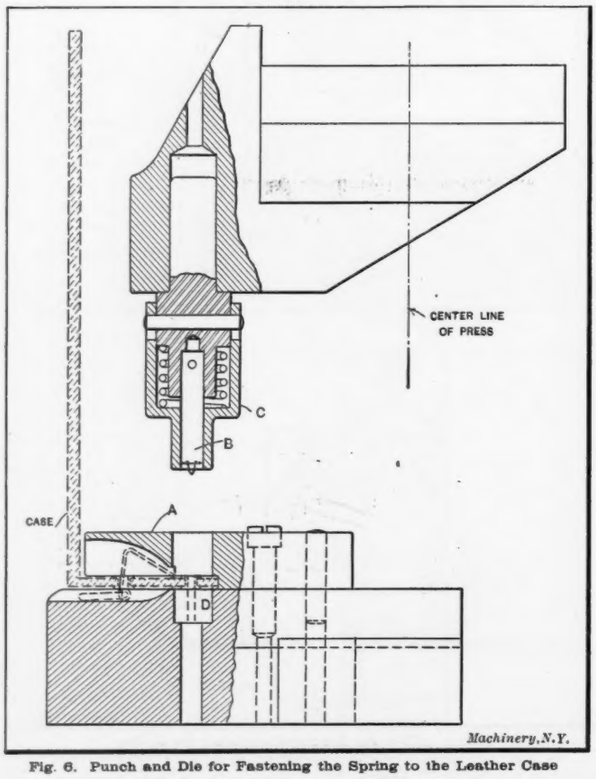


Fig. 6. Punch and Die for Fastening the Spring to the Leather Case

over the ring, and the ring then placed on the plunger *A*, with the spring in the gage *B*. When the ram descends, the pad *C* holds the spring and ring down on the base of the die, and the punch *D* completes the bending of the spring around the ring. The punch *D* also forces the plunger *A* down into the die, and as the ram of the press ascends, the punch *D* lifts the ring from the die. As the ram ascends still further, the pad *C* descends, stripping the blank from the punch. This completes the making of the spring clip. It is now necessary to fasten it to the leather carrying case.

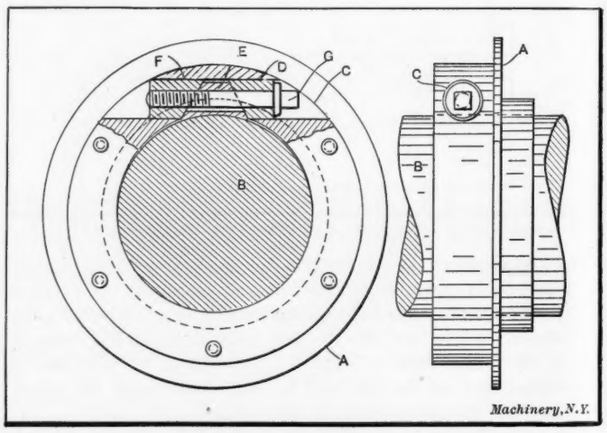
Before fastening the spring to the leather carrying case, the eyelet *F* (Fig. 1) is riveted in the case, but as the die for this operation is very simple it will not be necessary to show it. After the eyelet *F* has been riveted in the case, the spring can then be assembled. This is accomplished in the punch and die shown in Fig. 6. As can be seen from the illustration, this die is offset from the center of the press, so as to clear the ram.

In operation the spring is put through the eyelet *F;* then the eyelet *E* is inserted, and the case and spring placed in the die as shown. The stripper *A* is cut away to clear the spring. On the downward stroke of the press, the punch *B* bends the eyelet over the spring, thus fastening it to the case. The spring is held down on the case by the stripper *C*. A hardened steel block *D* is located in the die-block, on which the eyelet *E* rests. This block *D* has a hole in it which clears the teat on the riveting punch *B*. This completes the operations on the spring clip as shown at *G* in Fig. 1; a section only of the case is shown, as this is sufficient to illustrate the method of fastening.

* * *

FRICTIONAL LOCKING DEVICE

A frictional locking device, applicable to a large range of uses, but specifically applied in the patent to fastening the hand-adjusted reversible cutter-carrying bar of a paper board scoring machine, and also for fastening the cutters to their shafts in a paper or paper board slitting machine, is de-



Frictional Locking Device

scribed in U. S. Patent 974,156 (November 1, 1910) obtained by John G. Jones of Rochester, N. Y., assignor to M. D. Knowlton Co., also of Rochester.

The accompanying figure explains the mechanism, showing a paper-cutting knife *A* locked to the shaft *B*. The circular hole *C* contains three sleeves *D*, *E* and *F*, the latter one being threaded to receive the stud *G* which passes through the center of the sleeves *D* and *E*. The bore of *E* is larger than the bolt in order to allow lateral play, so that when *G* is tightened the sleeves *D* and *F* draw up on the sleeve *E* (the three sleeves having their inner ends tapered to bear upon each other) thereby tightening the sleeve *E* down on the shaft *B*. The lower side of *E* is gouged out to fit a small arc of the shaft. The figure clearly shows the details.

* * *

A power transmission plant is being erected at Lauchhammer, Germany, designed to generate current for transmission at a pressure of 110,000 volts, which is stated to be the highest voltage used for power transmission in Europe. The current transmitted is three-phase; the generator pressure is 5500 volts, which is transformed up to the transmission voltage by four transformers, each of 6800 kilowatt capacity.

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DIE-CASTING*—2

GENERAL PRINCIPLES OF DIE MAKING AND EXAMPLES

By A. C. VON DREELE†

The making of casting dies calls for ingenuity and skill of the highest order on the part of the die-maker. There is probably no class of die-making in which the work produced is more faithful to the dies, both in showing up the little details in the making that reflect credit on the dies, and in exposing the defects and shortcomings in the workmanship, if there be any. The castings from casting-dies or molds as they are sometimes called, may be produced in dimensions down to ten-thousandths for accuracy if necessary, and once the dies are made the castings will not vary in the slightest degree, if the working conditions are kept uniform.

In spite of the close work required in making casting-dies, the work is very fascinating. Perhaps it is on account of this accuracy; possibly it is on account of the fact that they are made from machine steel; but most likely it is because there are no hardening troubles to be contended with. Another factor that makes the work interesting is the ingenuity required in the work, for almost every die-maker, if he is worthy of the name, likes to figure out and plan for the best way of building a die for a difficult job.

General Principles of Casting-die Making

Casting-dies, or molds, have little in common with sand molds. It is true that the dies for die-casting are composed of two parts corresponding to the cope and nowel of the sand mold, but they are so different in every other way that no benefit would result from a comparison.

Generally speaking, casting-dies are made of machine steel; the parts which are exceptions are the heavy bases and frames, which are made of cast iron, and the dowel pins and small cores, usually made of tool steel. Except in rare instances, there are no hardened parts about a casting-die; this is the case because the melting points of some of the alloys that are die-cast are high enough to draw the temper from any hardened parts of the dies.

The ideal die is simple in construction, with as few parts as practicable; the castings should be easily ejected and should come from the dies as nearly free from fins as possible. To meet these requirements in the best way is the proposition that confronts the ingenuity of the die-maker. As the die is primarily in two parts, there must be a parting line on the casting. This line is always placed at the point that will permit the casting to be ejected from the dies in the easiest manner possible, bearing in mind the effect the joint will have on the appearance of the finished casting; this is a point far less important than with sand casting, for, if the dies are properly made this seam will be barely perceptible. When it is practical to do so, it is wise to have the parting line come on an edge of the die-casting. Draft is unnecessary on the straight "up-and-down" places, but of course it is impossible to draw any parts that are undercut. Means must be provided for ejecting the casting from the dies after completion and it is usually done by means of ejector pins, though frequently it is better to have the bottom of the die or some other section movable and do the ejecting on the same principle that is used on drawing dies of the compound type. On close work, shrinkage plays an important part, and the amount of shrinkage varies from 0.002 to 0.007 of an inch per inch. Aluminum shrinks the greatest amount, Parsons white brass shrinks considerably, while tin shrinks but little. Thus, it may be easily seen that to figure the shrinkage allowance for an alloy that contains three or four metals with different shrinkages, requires judgment. To prevent the air from "pocketing," air vents are necessary at frequent intervals around the die-cavity. These vents are made by milling a flat shallow cut from the die-cavity across the face of the die to the outside edges of the block. From ¼ inch to ½ inch is the usual width and from 0.003 to 0.005 of an inch, the customary depth, varying with the size and shape of the die in question.

The dies or molds for die-casting are of various styles, as are also punch-press dies, and it would be difficult to lay down specific rules for their classification. There are the plain dies, without complications of any kind; slide dies with one or more slides; dies for bearings, both of the "half-round" and of the "whole-round" types; dies for gated work; and many other less important classes. Then there are dies that have features that belong to more than one of these types, so that it is easily seen that to decide upon the style of die that would be best for a given piece of work requires a good deal of experience. Some of the most important of these types can best be shown by illustrating dies made in the various styles, showing, step by step, how the dies are made and assembled. To commence with, consider the making of a casting-die of the very simplest form.

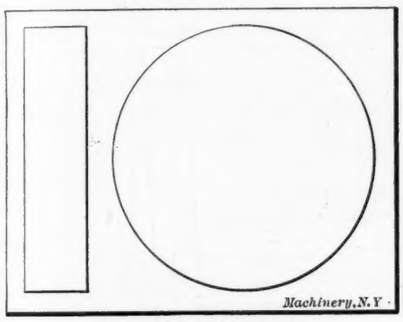

Fig. 8. Disk cast in Simple Casting-die

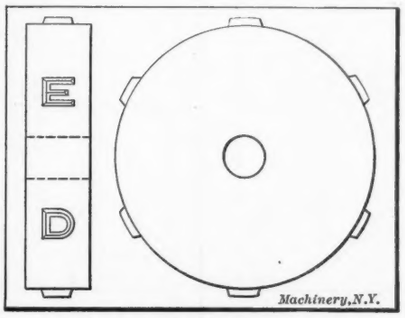

Fig. 9. Printing Wheel cast in a Slide Die

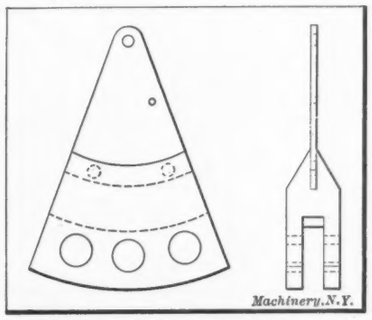

Fig. 10. Die-cast Weight with Inserted Sheet-steel Punching

Making a Plain Casting-die

In Fig. 8 is shown a plain flat disk made by die casting. In actual practice, a die would not be made for such a simple piece, unless there were some features about it that would prevent it being made on a screw machine or with press tools. It might have a cam groove cut in one of its flat sides, the sides might be covered with scroll work, there might be gear teeth around its circumference, or a hundred and one other conditions to make die-casting a desirable method of manufacturing. All these complications are omitted for the sake of simplifying this initial description of a casting-die.

Fig. 11 shows the die for this piece in plan and sectional elevation. *A* is a square cast-iron frame, made from a single casting. This frame or box, as it is generally called, is planed on the top and bottom only. Next, the two die-halves *B* and *C* are shaped up from machine steel. In this casting die, and in the majority of others, these die blocks are square. The lower half of the die *B* is held to the cast-iron frame by fillister head screws, set in counterbored holes, thus sinking the screw-heads under the surface of the block. The upper half of the die *C* is located upon *B* by dowel pins driven into *B* which have a sliding fit in the reamed holes in *C*. This being done, the die-half *B* is fixed to the faceplate of the lathe and the recess bored for the die-cavity. This operation is a simple one in this case, for it is merely a straight hole one-half inch deep and three inches in diameter. Of course this recess must be carefully finished with a tool that has been stoned up

* The second and concluding article of this series, the first of which appeared in the January issue.

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to a sharp edge, using lard oil. Emery cloth should be used as little as possible. It is unnecessary to give this hole draft, but it must be free from ridges or other marks that would prevent the casting being pushed out. If the faces of the dies are spotted with a small piece of boxwood or rawhide held in the drill press and kept charged with flour emery, the die-casting will reproduce this "birds'-eye" finish and the appearance will well repay the few minutes additional time that it will take. The spotting should be done with dry emery (without oil) to get the brightest finish. The upper die-half *C*, is simply ground on its working face. The outside corners and edges of the faces of both die-halves should be well rounded off so as to insure the absence of slight dents or rough places that might prevent the dies from fitting perfectly.

The ejecting mechanism must next be considered. Lever *D*, pivoted from bracket *E*, has a steel pin *F* that engages in the elongated hole in bracket *G*, so that an upward pull of the lever *D* raises bracket *G*, which is attached to ejector-pin plate *H*. This plate is a loose fit over the guide screws *I* that are attached to the lower die-half *B*. The ejector pins *J*, four in number, in this die, are riveted into the ejector-pin plate, and they work through holes drilled and reamed through the lower die-half. The ends of these pins must be finished off so as to lie perfectly flush with the inside of the

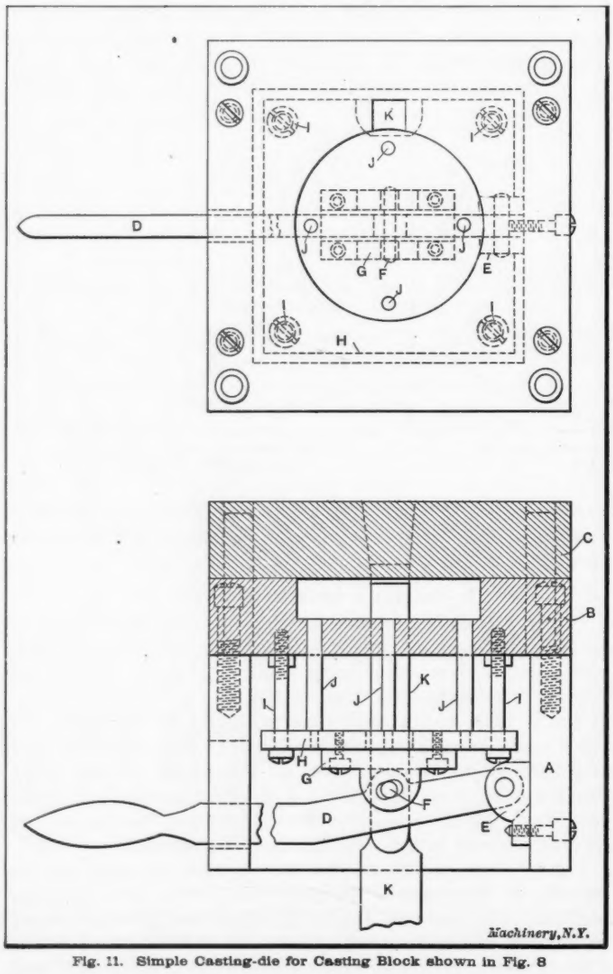

Fig. 11. Simple Casting-die for Casting Block shown in Fig. 8

die when ready for operation and, of course, they must be a sliding fit in the holes in the die.

An important feature of a casting-die is the sprue cutter, shown in this die at *K*. If the disk for which this die was made, had had a hole or central opening of any kind, the sprue cutter would best be operated at that point; but, as this disk is plain, the sprue cutter must be placed at the edge. At the outside of the die-cavity, as shown in Fig. 11, the opening for the sprue cutter is laid out, drilled and filed to shape. It is obvious that the side of the sprue cutter adjacent to the die must fit the outline of the die perfectly, so that there will be no break in the appearance of the casting. The opening for it is extended through the upper die-half, and from a point ¼ of an inch from the inside face of the die this hole is flared out nearly as large as the opening through the die-plate of the machine. Of course the aperture in the upper die-half must be no larger than the opening through the die-plate; otherwise the sprue could not be pushed out. The sprue cutter itself is a long rod, whose section is of the same shape and size as the openings just made, and it is connected to the sprue cutting mechanism of the machine. Of course it is unnecessary to shape the entire length of the sprue cutter to size; after the working end is milled to shape for a distance of six or eight inches, the rest of the rod may be left round. The sprue cutter is finished first, after which both the openings in the die are fitted to it; and while the fit should be metal tight, it must be perfectly free to slide.

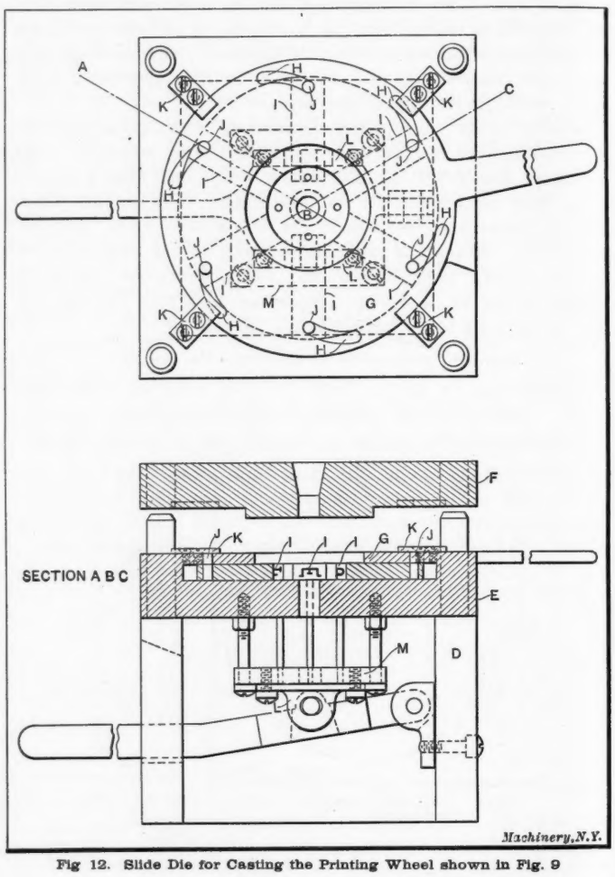

Fig 12. Slide Die for Casting the Printing Wheel shown in Fig. 9

The dies are mounted on the die-plates of the casting machine by means of straps, much the same as bolsters are held on punch press beds. The position of the die on the die-plate must be such that the opening for the sprue cutter will line up with the nozzle at the outlet of the cylinder. At the time of casting, the position of the sprue cutter is as shown in the illustration of this die, Fig. 11. In this position there is room for the metal to enter the die-cavity, and yet there is but a small amount of metal to be cut off and pushed back after the die has been filled with metal.

With slight modifications, the above style of die may be used for die-casting any piece that will draw or pull out of a two-part die. If holes must be cast through the piece, it is only necessary to add core pins to the lower die *B*, a point that will be more fully described later. It is unnecessary to add that both halves of the die may be utilized in making the cavity for the die, should they be needed. Also, it is often easier to machine out the recess larger than is needed, and set in pieces in which parts of the outline of the die-casting have been formed. Gear teeth are put in the die in this way; a broach is cut similar to the gear desired, then hardened and driven through a piece of steel plate which is afterward fitted to its place in the die.

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Slide Dies

The die illustrated in Fig. 12 is one of the most successful of the various types of casting-dies, and if properly made is an interesting piece of die work. The principal use of this particular style of die, called a slide die, is to cast parts like the one shown in Fig. 9, which is a disk similar to the one which the last die described was to cast, except that it has raised letters at the edge and a hole in the center. It is obvious that the die last described, (Fig. 11) would not do for disks or other pieces having projections or depressions around their edges, as, for instance, printing or counting wheels with raised or sunken characters, or grooved pulleys. Briefly, this style of die is similar to the simple casting-die, except that slides are provided, to the required number, which form the edge of the casting. A die for a plain grooved pulley would

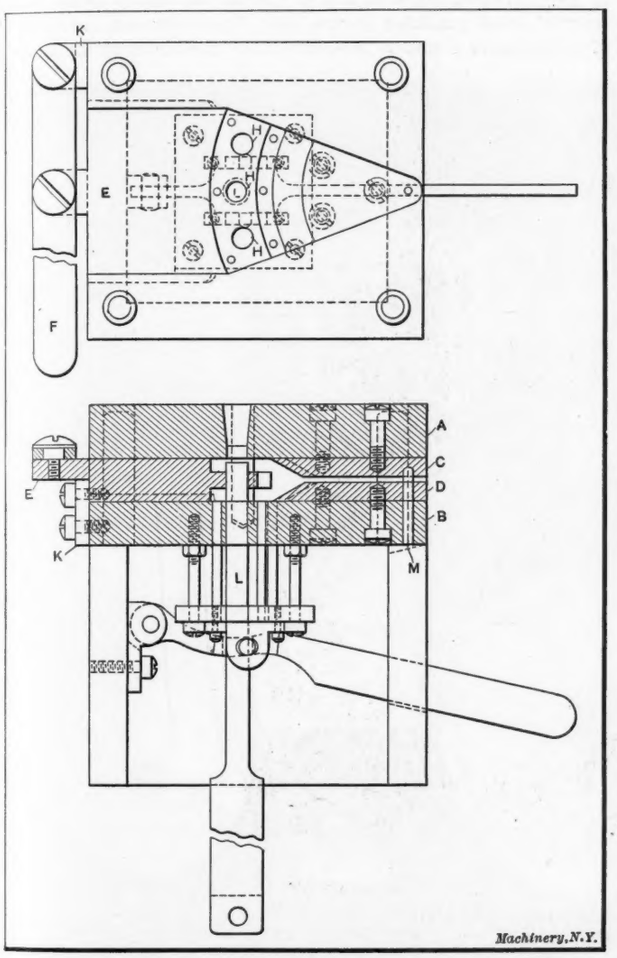

Fig. 13. Casting-die for Making Castings with Inserted Pieces like that shown in Fig. 10

require but two slides, while a die for a printing wheel with forty letters around its edge would necessitate forty slides, one for each of the letters. The die about to be described, shown in Fig. 12, was made to cast a wheel with six raised letters as shown in Fig. 9.

Referring to Fig. 12, *D* is the cast-iron box or frame, *E*, the lower die, and *F* the upper die. In making the lower die-half, the stock is first shaped to size and doweled to the blank for the upper die-half, and the holes for attaching to the frame are drilled. For the sake of clearness, these holes and screws are omitted from the illustration as are also the vents, since they have been fully explained. The lower die is next strapped to a faceplate, trued up, and bored out nearly to the diameter of the body of the piece to be cast, exclusive of the raised letters. The depth of this recess is equal to the thickness of the printing wheel plus 3/16 inch to allow for the cam ring *G* that is used to reciprocate the slides of the die. The cam ring is made large enough to cover the die-cavity as well as the slides that surround it, with an allowance of an inch or two for the cam slots *H*. The six slides *I* are made long enough to have good bearing surfaces. With the size of the cam ring determined, the die is next bored out to receive this cam ring and the last inch of the recess is carried down to the depth of the die cavity so as to make an ending space for the slots that the slides are to work in. The die is now

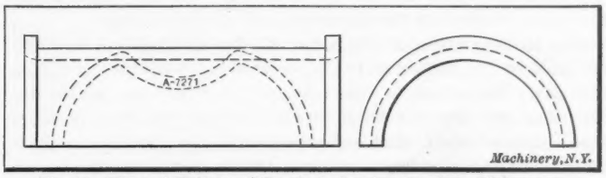

Fig. 14. Die-cast Half-round Bearing, showing the Cast Oil Grooves

taken from the faceplate and the slots for the slides laid out.

These slots may be milled or shaped but milling is to be preferred. The next step is the making and fitting of the slides, which are of machine steel, having a good sliding fit in the slots. The six slides are fitted in position and left with the ends projecting into the die proper. The slots *H* are next profiled in the cam ring *G*, and the pins *J* that work in them are made and driven into the holes in the slides. With the slides and cam ring in place, the cam ring is rotated to bring all the slides to their inner position where they are held temporarily by means of the cam ring and temporary screws. The die-half with the slides thus clamped in the inner or closed position, is set up on the lathe faceplate and the die-cavity indicated up and bored out to the finish size, which

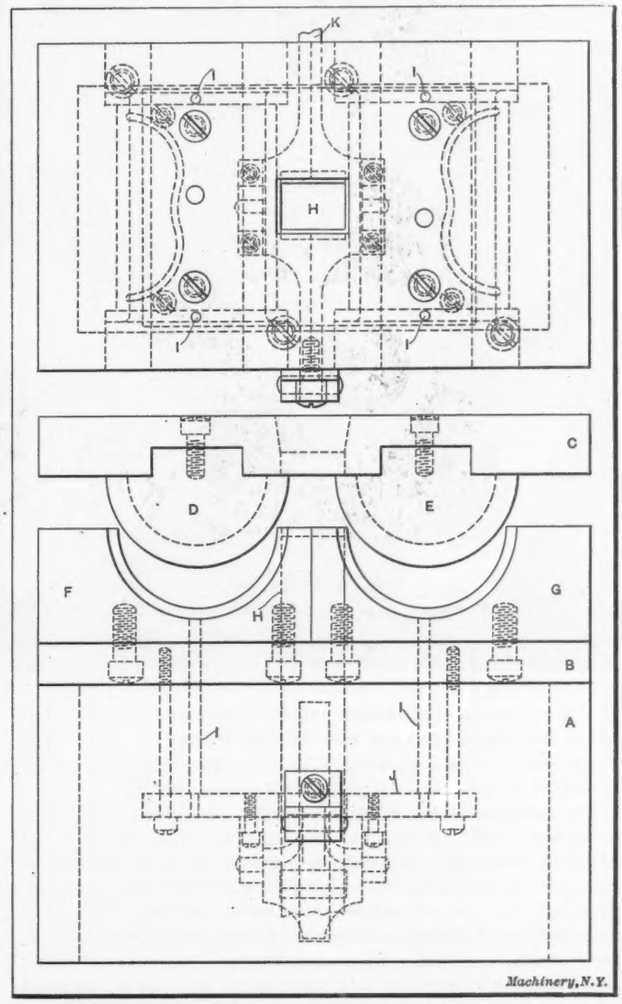

Fig. 15. Casting-die for the Half-round Bearing shown in Fig. 14

operation also finishes the ends of the slides to the proper radius. The die may now be taken down and the slides removed to engrave the letters upon their concave ends. The engraving can be done in the best manner on a Gorton engraving machine, but if such a machine is not available they may be cut in by hand. Stamping should never be resorted

to for putting in the letters, because the stock displacement would be so great that it would be impossible to refinish the surface to its original condition. Before fitting the cam ring, an opening must be milled in the die to allow the handle to oe rotated the short distance necessary. After the cam ring has been fitted, it is held in by the four small straps *K*, attached by screws to the lower die-half at the corners.

The sprue cutter, which is not shown, is operated through the hole in the center of the piece and is, of course, round in this die. Its action is the same as was the one previously described, and the ejecting device is similar, with the exception that the brackets *L* that are attached to the ejector-pin plate *M*, are widely separated so as to make room for the sprue cutter that works through a hole in the plate *M*.

Die for Casting with Inserted Pieces

For making die-castings that are to have pieces of another metal inserted, it is necessary to have a die with provisions for receiving the metal blank and holding it firmly in position while the metal is being cast around it, and of course the piece must be held in such a manner that it can be easily withdrawn from the die with the finished casting.

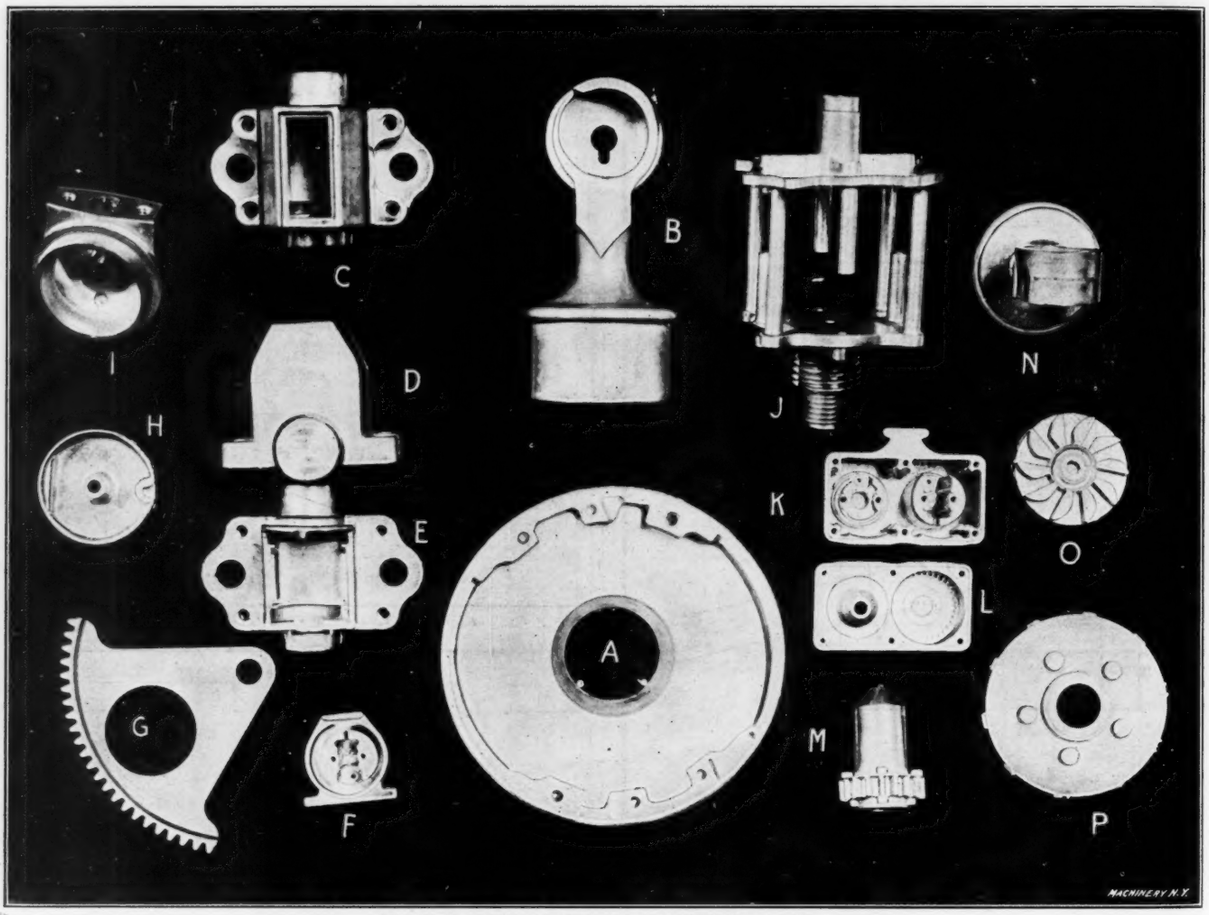

Fig. 16. Examples of Die-cast Parts for Telephones, etc.

The die illustrated in Fig. 13 is for a part that is used as a swinging weight, shown in Fig. 10. The upper part of the piece is made from a sheet steel punching, so as to lighten this part of the piece as well as to give increased strength, especially at the hole at the pivoted end of the work. The cast portion of the piece is slotted lengthwise, as the illustration shows; and three holes pass through the casting, piercing the sides of the slot. In addition to showing the method of making dies for inserted pieces, this die shows the principles of simple coring.

In making this die, two machine-steel blanks are planed up for the upper and lower halves of the die, *A* and *B*, the lower die being made nearly twice as thick as the upper die because it is in this part that the most of the die-cavity will be made. In this lower half of the die the stock is milled out the same shape as the outline of the plan view of the casting, being carried down to the exact depth of the thickness of the casting. From the wide end of this recess the stock is milled or shaped out in a parallel slot to the outside of the die-block. At the bottom of the side of this wide slot are T-slots to guide the slide *E* that is to work in this opening. The slide is milled and fitted to the T-slots and opening in the die, but is left considerably longer than the finish size. Next, the slide is mounted on the faceplate of a lathe and turned out on the end with the proper radius and a tongue to form the slot that is to be in the curved end of the casting. At the outer end of the slide is left a lug that is drilled and tapped for the operating lever *F* that reciprocates the slide, using the stud in bracket *K* as a fulcrum.

Two pieces of machine steel are next shaped and finished up to form the chamfered part of the casting and to locate the inserted steel punching in the die. The combined thickness of these pieces *C* and *D* is equal to the thickness of the casting, less the thickness of the inserted piece. It is now an easy matter to seat section *D* in the bottom of the milled part of the lower die-half, and to locate section *C* in its proper position on the upper half. A pilot pin *M* is fitted in *D* to hold the steel punching in position by means of the hole that is in the extreme upper end of the punching. The pilot pin extends through this hole into a corresponding hole in section *C*. At the lower end of the steel part that is inserted, there are two holes whose object it is to secure the punching to the die-casting, for the molten metal runs through these holes, practically riveting the die-casting to the inserted piece.

Provision has now been made for holding the sheet-metal part that is to be inserted, and the cavity has been completed for the casting, including the tongue at the end; it now remains to describe the manner of forming the holes that pierce the casting through the slotted portion. In the lower die-half the positions of the three holes *H* are laid out, drilled and reamed. Then, with the two die-halves together and the slide clamped at its inner position, the holes are transferred through

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the slide and the upper die. This being done, it is an easy matter to make core pins and drive them into the upper die at the two end holes, the center hole being taken care of by the sprue cutter *L* that will be described later. The core pins should be a nice sliding fit through the slide and in the holes in the lower die, into which they should extend from a quarter to a half an inch. In addition to coring the holes, these pins act as a lock to hold the slide *E* in its proper position at the time of casting.

The sprue cutter *L* is most conveniently operated in the center hole, thus doing away with the core pin that would otherwise be required. The sprue cutter needs little description in this die, for as in the slide die, it is merely a plain round rod that fits closely in the holes through the dies and slide. The ejector mechanism is the same in this die as in the dies already described; therefore further description is unnecessary.

The operation of this die is very simple. The sheet-steel piece is laid in the recess in the open die, being located by the pin *M*. Slide *E* is thrown in by means of lever *F*, and the dies are closed. At the time of casting, the sprue cutter is in the position shown in the sketch, being nearly through the die-cavity. As before explained, this position admits the molten metal to pass into the die cavity but still leaves very little sprue to be cut off after the die-casting is completed. It should be stated that the steel piece that is inserted must be perfectly flat and free from burrs that would prevent the die-halves from coming together properly.

balanced in a better manner. As with other dies, the first step is to machine up the frame *A* and the two die-halves *B* and *C*. The pieces *D* and *E* that are to form the insides of the bearings are then turned up and one side of each shaped and keyed to fit the slots that have previously been milled in die-half *C*. These parts are held in place by dowels and screws. One of the bearings produced by this die is shown in Fig. 14, and it will be noticed that there is an oil groove within that covers the length of the bearing. To produce this groove in the die-castings, a shell must be turned up and bored out whose inside diameter is that of the inside of the bearing, and whose thickness equals the depth of the oil groove. This being done, the oil grooves are laid out upon the shell and cut out by drilling and filing. After rounding the outside corners, these little strips are pinned to the cores *D* and *E* in their proper places and that part of the work is done.

Another little kink in this connection is worthy of noting, especially as it was originated by the writer and has never been shown before. So many different styles and sizes of

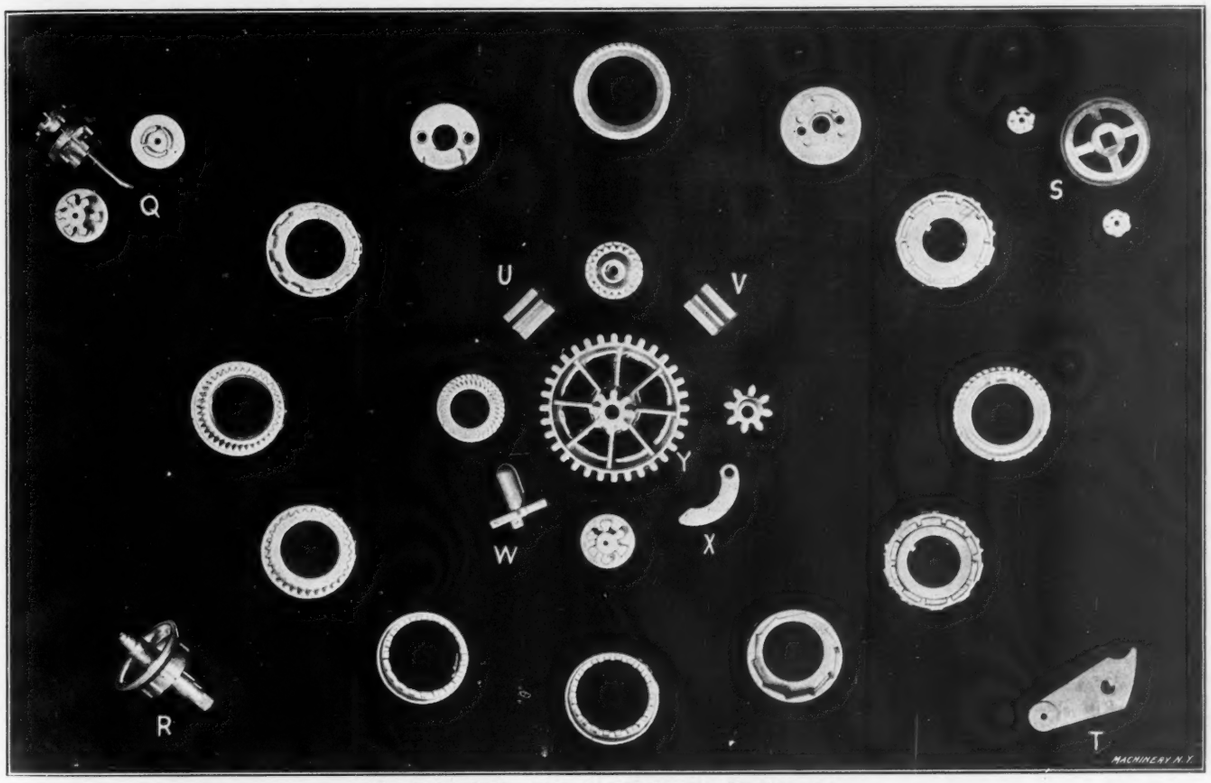

Fig. 17. Small Die-cast Parts of Cyclometers, Watches, etc.

Bearing Dies

Bearing dies are one of the most important of the various classes of casting-dies. The bearings produced by die-casting are so far superior to those made by other casting methods and machining that their use is now very extensive. Dies are made for "half-round" and "whole round" bearings. There is little out of the ordinary about a whole-round die, but the half-round die involves many interesting methods of die-making and for that reason is here described.

Fig. 15 shows a casting-die for half-round bearings. Half-round bearing dies are usually made to cast two bearings at a time, for the reason that it is just as easy to cast two pieces of such a shape as it is to cast one, and, in addition, the die is

bearings are made by a concern doing much die-casting that it is essential that the die-cast bearings should bear some distinguishing number to identify them. As this number is of no consequence to the user it is well to have the number in an inconspicuous place, but it must be where it will not be effaced by scraping, etc. Bearing in mind that it is much easier to produce raised lettering by die-casting than to produce sunken lettering, it will be readily seen that the oil groove affords a good place in which to put the bearing number. This is easily done by stamping the figures upon the narrow strip that forms the oil groove. In this place on the bearing it may be easily found if needed and of course there is no danger of its being taken out by machining.

The lower die consists of two blocks *F* and *G*, each of which contains an impression of a bearing. The best way to get these parts out is to lay out the ends of each of the blocks with the proper radius, taking care to have the center come a little below the surface of the face of the block. Then the blocks should be shaped out to get the bulk of the stock out, before setting up in the lathe. After the lathe work is done on each piece, which of course is usually done separately, the faces of the two blocks are faced down just to the exact center of the impression. It will be noticed that two blocks are used for

the lower part of the die. The reason is to facilitate the locating of the female parts of the die in proper relation to the male parts. After properly locating, they may be doweled and screwed to baseplate *B*.

The sprue cutter *H*, better shown in the plan view, is square in shape and connects with the die-cavities in a thin narrow opening on either side of the sprue cutter. The ejector pins, *I*, two to each die, are at the ends of the bearings. The ejector-pin plate *J* is necessarily large, and is operated by lever *K*.

The illustrations Figs. 16 and 17 are photographs of die-castings made by the Veeder Mfg. Co., of Hartford, Conn., who make hundreds of thousands of die-castings annually for use in the cyclometers and odometers that they manufacture as well as large quantities of die-castings for other firms who are not equipped to do their own work. The casting machines of the Veeder company are all automatic and they are able, after the dies are completed, to turn out the die-cast product very rapidly.

Referring to Fig. 16, *A* is a telephone transmitter that is used in connection with *B* and *N*, as parts of a telephone desk set. These parts are die-cast complete as they appear in the photograph, ready for assembling, and the fine surface finish that they possess is very noticeable. It is obvious that very little buffing would be required before plating such pieces. At *C* is a cyclometer case consisting of two die-castings, a base and a cover. These are shown separated at *D* and *E*. These specimens splendidly illustrate the possibilities in making good fits by casting, for cover *D* is cast a nice sliding fit over the vertical part that extends from the base. So accurately fitted are they, that it requires a careful, straight pull to separate them. At *F* is an odometer part, consisting of a case and barrel, cast integral; *G* is a segment used in a cash register, showing gear teeth made by die-casting; *H* is a register wheel with sunken figures, used in a voting machine; while *I* is an angle bracket used in electrical work. *J* shows a specimen of die casting in the form of a frame for a water-meter movement that involves some interesting features. The frame consists of but two castings; the lower half has the four corner posts and two others, midway of the ends, cast integral, while the upper half has the two posts at the sides cast in a similar manner. The corner posts are cast at the ends to fit corresponding holes in the top plate. The ends of these posts are slightly hollowed so that the ends may be easily spun over after assembling. Naturally, these holes and the posts that enter them must correspond perfectly. The threaded portion at the bottom also tends to make the job interesting, for the two threaded sections are of different diameters and pitches. The parts are cast of a somewhat softer alloy than usual, on account of the spinning that must be done in assembling.

All of the Veeder castings shown represent good die work, but the die-castings at *K* and *L*, a double cyclometer case and cover, are specimens of the highest class of casting-die making. The case is an oblong box, ¾-inch wide by 1½-inch long and ⅝-inch deep, and within are two bearing studs which have holes, lugs, pins and slots cast in the one operation. The cover, which is cast with a seat that fits the case perfectly, is hollowed out to make room for an internal gear on the one side, while on the other side is raised a bearing for part of the mechanism. *O* is a voting machine register wheel; *M* shows a water-meter gear; and *P* illustrates a printing wheel for a fare register.

Fig. 17 shows some of the smaller class of Veeder die-castings. At *Q*, and on either side of *S*, appear illustrations of small pinions for the Veeder "set-back" cyclometer. *R* is a part used in odometers; *S* is a handle for a combination lock; and *T* and *X* are watch parts. The face of the part *T*, is covered with imitation engraved work and the effect is very pleasing. *U* and *V* represent an interesting use for die-castings as made into rifle sights, and on this work the dimensions are held very close. The two sights shown differ only by a few thousandths. *W* represents a part for a cash register and the combined gear and pinion at *Y* is used in water-meter work.

The other illustrations in Fig. 17 are parts of cyclometers in the form of register wheels, gears, sleeves, etc., and show some excellent work, especially in various forms of gears, both internal and external. These illustrations convey some idea of the extent that die-casting has played in revolutionizing the cyclometer manufacturing industry, and present indications show that it bids fair to do as much for other branches of manufacturing.

In casting machines where the plunger is operated by compressed air, the gages are held at a pressure anywhere from 80 to 120 pounds per square inch. As can be readily seen it does not require as much pressure on soft alloys, as it does on the hard ones. However, it is a fair statement to say that the average would be somewhat over 100 pounds per square inch.

* * *

BOLLINCKX BABBITTED BEARINGS

The two views Figs. 1 and 2 show a method of securing babbitt in bearings, developed and patented by H. Bollinckx, Brussels, Belgium. The common manner of securing the babbitt, is by means of dovetailed grooves into which the metal runs while hot. This method has certain disadvantages, largely due to its higher cost occasioned by the necessary core boxes for casting, etc., and also to the difficulty of obtaining

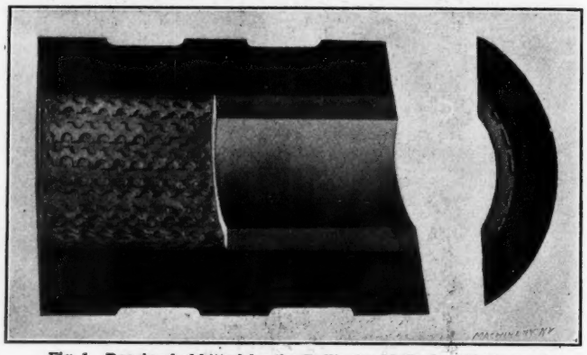

Fig. 1. Bearing babbitted by the Bollinckx Method, with Part cut away to show Construction

a perfect shape, for frequently, the shrinkage separates the metal from these dovetailed grooves. It was with the idea of overcoming these disadvantages that the bearing described was invented. By reference to both Figs. 1 and 2 it will be seen that the babbitt is held in position by perforated strips of

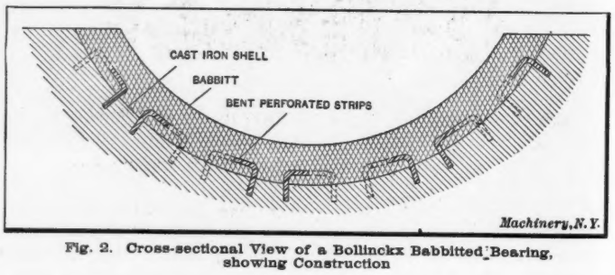

Fig. 2. Cross-sectional View of a Bollinckx Babbitted Bearing, showing Construction

metal bent longitudinally in the form of a "U." The edges of the "U" are cast into the iron bearing, thus forming an integral part of the casting. The babbitt metal is then poured into position and running under these perforated strips is securely held in a manner similar to the reinforcing strips in concrete work. These strips or liners being tinned. allows the babbitt to amalgamate with them, thereby forming a perfect union. They also tend toward the rapid cooling of the babbitt during the casting process, which avoids the usual setting, giving the metal greater homogeneity.

* * *

An unusual case of the possibility of the human body to withstand the effects of a high voltage is mentioned in the *Industritidningen Norden*. The master mechanic in a textile mill in Norrköping, Sweden, came in contact with the high-tension conductor to the mill, carrying a pressure of 3000 volts. The current was conducted through his body to the ground, and while he lost consciousness, he afterwards recovered. The visible effects were comparatively small, the hair only being singed.

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EXTERNAL CUTTING TOOLS—2

PRACTICE FOR THE BROWN & SHARPE AUTOMATIC SCREW MACHINE

By DOUGLAS T. HAMILTON*

In the previous article on external cutting tools, various methods of applying turning tools, and also methods of holding and adjusting them were illustrated and described. In this article, which is a continuation of the series on external work, the following subjects will be treated in detail: Application of box-tool supports to the work, and methods of holding and adjusting them; cutting angles for box-tool cutters, and adjusting the tangential cutter for turning different diameters.

Applications of Box-tool Supports to the Work

The type of support to use and the method of applying it are governed largely by the following conditions:

1. Shape of the stock, whether round or otherwise;
2. Character of the cut, whether taper or otherwise;
3. Nature of the material, whether soft or hard;
4. Number of different diameters to be turned;
5. Length of the work being turned;
6. Clearance allowable between the face of the circular form tool and box-tool.

These various points should be taken into consideration before designing a box-tool.

At *A* in Fig. 4 is shown a box-tool support which is commonly used in roughing box-tools. This support envelopes the work and precedes the turning tool. Its use is mainly for turning down cylindrical work in which the finished diameter is to be concentric with the part which is not finished, that is, which has not had a cut taken from it. Where the work being turned projects more than five times its diameter from the

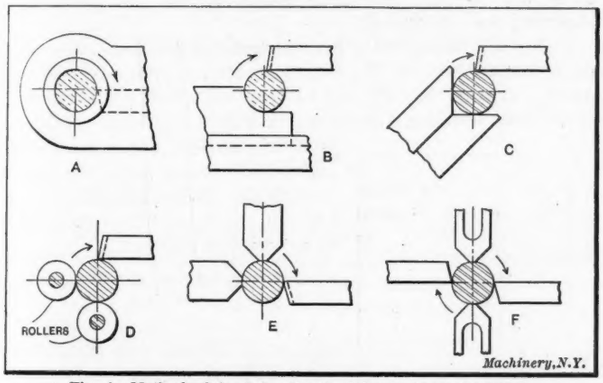

Fig. 4. Method of Applying Box-tool Supports to the Work

chuck, and is of large diameter, it is not advisable to use a bushing support, unless the stock is reduced by the circular cut-off tool, as was described in the previous article.

At *B* is shown a support which is recommended by some authorities for finishing box-tools. As a rule this support should be used sparingly, and in fact, the writer would suggest that it be entirely dispensed with, particularly where the work has not been previously turned. There are a few objections to this support, especially when it is made solid with the holder, among which the following might be given: As this support does not envelope the work, a bar which is larger in diameter than the hole in the support can be turned; therefore, the support throws the bar to one side, so that it is not in line with the chuck, thus producing work which is not straight, but is slightly tapered. At times this is objectionable, and can be avoided if an adjustable support is used. It is also sometimes suggested to drill this support in the machine in which it is to be used, and after hardening to lap it in the machine also. This seems a roundabout way to make a support for a box-tool, when it is a very simple matter to have the box-tool support adjustable.

The support shown at *C* has not the objectionable features that were mentioned regarding that shown at *B*. This support is commonly called a V-support, and has a two-point bearing on the work. As shown in the illustration, the thrust from the tool is against both supports. As a rule, this support should not precede the cutting tool, for the reason that if the work is not cylindrical in shape, the irregularities of the bar will be reproduced on the work that is turned, so in using a V-support it is always best to have the cutting tool precede the support an amount varying from 0.010 to 0.015 inch. This V-support can be used for brass, steel and similar materials, and gives satisfactory results when it does not precede the turning tool.

In turning cast iron, aluminum or materials of a similar character, difficulty is sometimes encountered in producing a finished surface on the work. This is usually due to fine chips or dust getting in between the supports and the work, thus causing an abrasive action which roughens up the work. It is therefore advisable when turning aluminum, cast iron or materials of a similar character, to use roller supports. One method of applying the roller supports is shown at *D*. These rollers should be hardened and ground, and it is usually preferable to lap them also, so that they are made very smooth. It is obvious that this support rotates with the work, and hence has not the objectionable features mentioned in connection with the V-support. This support is also used when turning machine steel, and is made to bear rather hard against the work, which gives it a burnished appearance.

Another support which is sometimes used for cast iron is shown at *E*. This gives a two-point bearing, and allows the tool to be set radially to the work. This support, however, is not as efficient as the roller support and therefore is of limited use, especially for materials such as cast iron, aluminum, etc.

At *F* is shown a method of supporting the work when applying two turning tools to it. This is used principally for roughing down steel work. The supports, as shown, are set at right-angles to the tools, and one tool acts as a support for the other in a horizontal direction. This manner of turning steel work is used largely when it is necessary to rough down the work from a large to a small diameter in the least possible time.

As a rule, supports for box-tools should be made from high-carbon steel, although where a box-tool is used on work which has a low periphery velocity, supports made from ordinary carbon steel can be used. But, as this is not often the case, especially on the automatic screw machine, supports made from ordinary carbon steel are seldom used. Supports made from Styrian steel are used extensively for box-tools, owing to the fact that this steel can be given an extremely smooth finish, which is one of the chief requisites of a box-tool support.

Holding and Adjusting Box-tool Supports

There are various methods used for holding and adjusting box tool supports, some of which are shown in Fig. 5. At *A* is shown a common method of holding a bushing support. This is driven into the body of the holder and is held with a cone-pointed screw *a*, which is located in a spot drilled in the bushing. The bushing as shown is straight, but it is sometimes advisable to make the bushing with a shoulder on it, so that if a large piece of stock is encountered, it will not force the bushing back against the cutting tool. Of course, this is an extreme case, and where the stock varies to such an extent, the bushing support should not be used. At *B* is shown a method of holding a support similar to that shown at *B* in Fig. 4. The adjustment in this case, however, is only longitudinal along the body of the holder, there being no provision for variations in diameter. *C* shows one method of holding a V-support. A rectangular hole is cut in the body of the holder in which the supports fit. When in position the supports are held by the set-screw *b*. This method of holding a V-support is commonly used for both roughing and finishing box-tools, where one cutting tool is applied to the work, and sometimes where two cutting tools are used, which are so close together that it is only necessary to support the work on one diameter.

At *D* is shown a method of holding a V-support, where it is necessary to apply more than one support to the work, as in the case when turning down more than one diameter at a time. This support is held in a movable block *c*, which is

* Associate Editor of MACHINERY.

adjusted along the body of the holder. This block *c* is held to the holder by the cap-screw *d*. A slot is cut in the body of the holder, in which this cap-screw is adjusted, and a groove is also cut in the holder to fit a projection formed on the base of the holder *c*. The supports in this case are held in the holder by means of a set-screw, as was shown at *C*.

These last two methods are principally for box-tools used for turning brass or a similar class of materials, in which the cutter is set radially to the work. At *E* is shown a common method of applying the V-support to a box-tool used for cutting steel and work of a similar character. This method of applying a support is used when the cutting tool is set tangentially with the work. The support is held in a rectangular hole cut in the body of the box-tool, by a set-screw, as shown.

The methods shown at *C*, *D* and *E* are limited in their scope, to a certain extent, owing to the fact that they cannot be used in conjunction with a circular form tool, when it is necessary to have the tool work closer to the forming tool than the thickness of the web *c*. For this class of work the method of holding a support shown at *F* is commonly used. This support is beveled as shown, and set in a correspondingly beveled slot cut in the front end of the box-tool body. As it would be impossible to bind these supports by having a screw pressing on top of them, it is necessary to split the body of the holder, and have screws pass through the two parts, as shown, binding them together. A clearance hole for the body of the screw is drilled in the upper part, while the lower part is tapped out to fit the screw. As this method depends on the elasticity of the material, it is usually best to drill a hole varying from ¼ to ⅜ inch at the rear end of the slot, to facilitate the drawing of the two parts of the body together, which is necessary to bind the supports in a rigid manner. There is one objection to this method of holding a support, *viz.*, the difficulty of applying the turning tool (in some cases) due to the fact that it comes very close to the face of the box-tool, which is objectionable in hardening.

As was previously mentioned, difficulty is sometimes encountered in turning cast iron, aluminum and materials of a similar character, owing to fine chips or dust getting in between the box-tool supports and the work. It was also mentioned that roller supports were found to be advisable for this class of work. At *G* is shown a method of applying roller supports. These roller supports are held to two movable members, *f* and *g*, which, in turn, are fastened to the body of the holder by the clamping screw *h*. These members, *f* and *g*, are cut out so that they fit into each other and form a sort of "mortised" joint. As the clamping screw *h* would not be sufficient to hold these roller-support holders against the pressure of the cut, they are held in the correct position by large-headed screws *i*, which are screwed into the body of the holder.

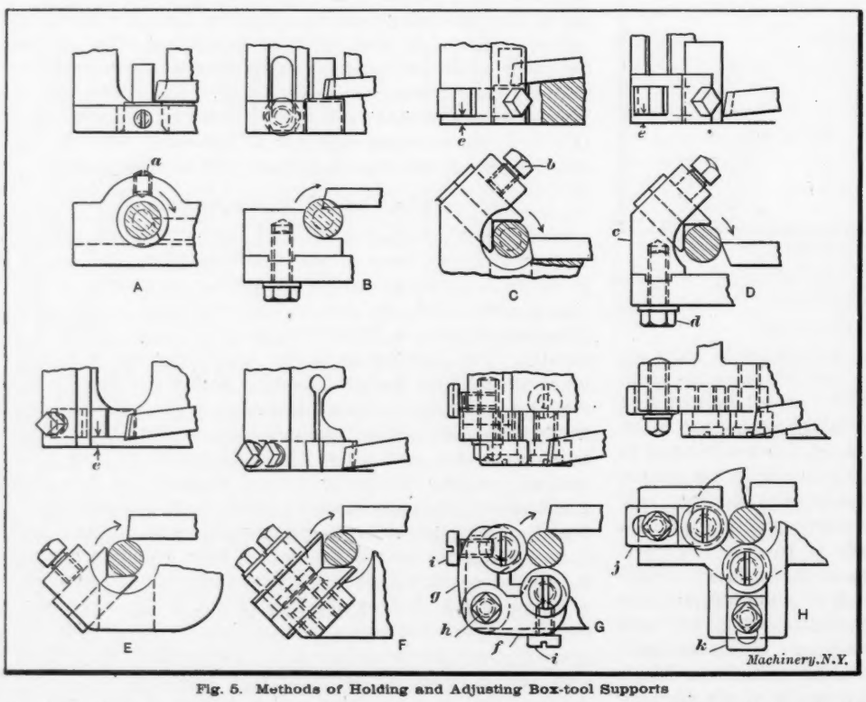

Fig. 5. Methods of Holding and Adjusting Box-tool Supports

At *H* is shown another method of applying roller supports. In this case the supports are held on two sliding holders, *j* and *k*, which slide in grooves cut in the box-tool body. They are adjusted in and out to the required diameter, and held by the clamping screws, as shown. This method of holding the supports is more rigid than that described in connection with *G*, and should in most cases be used in preference. Naturally there are various conditions which govern the method of applying these supports.

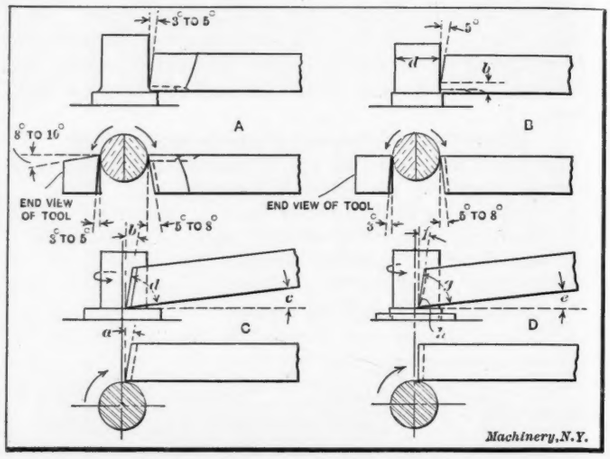

Fig. 6. Cutting Angles for Box-tool Cutters

There are numerous other methods of holding roller supports, but as they are of a somewhat similar character to those already shown, they will not be dealt with here. The methods of holding supports illustrated in Fig. 5, are those generally used in standard box-tools, and do not include those used for special conditions. Special applications of box-tool supports will be dealt with in subsequent articles.

Cutting Angles for Box-tool Cutters

It is not sufficient to hold a box-tool cutter rigidly, and support the work well, to obtain good results, but it is also necessary to have sufficient clearance, and the correct cutting angle on the tool. That is, the tool must have sufficient clearance and rake, so as to remove the superfluous material with the least possible resistance and power. The manner in which the tool is applied to the work, and the material on which it operates, govern the cutting angle on the tool. Generally, in automatic work, for cutting brass, the box-tool cutter is set radially to the center, as shown at *A* in Fig. 6. For taking a roughing cut on brass with the turning tool set radially to the work, the tool should be ground to the shape shown at *A*.

When taking a finishing cut on brass work, the tool is ground to the shape shown at *B*. Here a portion of the cutting surface, equal to the distance *b* is made parallel, so as to produce a smooth finish on the work. For usual conditions b equals $\frac{d}{5}$, where d equals the smallest diameter of the work being turned. It will be noticed in both these cases that the

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tool is not set at an angle with the face of the work, but is set parallel with it. While this method of setting the tool can be used for brass work, it is not advisable for steel work, as it does not give as satisfactory results as the tangent cutter. A turning tool set tangentially with the work is shown at *C*. The angles on the tool for cutting the materials as specified are as follows:

Cutting Angles for Machine Steel	Cutting Angles for Tool Steel
a = 10 degrees,	a = 8 degrees,
b = 10 degrees,	b = 8 degrees,
c = 8 to 10 degrees,	c = 8 to 10 degrees,
d = 70 to 72 degrees.	d = 72 to 74 degrees.

The method of grinding the tool shown at *C* is commonly used for roughing cuts, and will not produce an absolutely square shoulder on the work. For finishing cuts the tool is ground as shown at *D*, which produces a square shoulder on the work. The cutting angles for the materials specified are as follows:

Cutting Angles for Machine Steel	Cutting Angles for Tool Steel
e = from 10 to 12 degrees,	e = from 8 to 10 degrees,
f = from 15 to 18 degrees,	f = from 8 to 10 degrees,
g = from 60 to 65 degrees.	g = from 70 to 74 degrees.

While the cutting face on the tool shown at *D* is straight, it is usually advisable, especially when cutting machine steel and Norway iron, to give more lip to the tool, as is clearly shown by the dotted line *h*. This produces a curling chip and is conducive to better and more efficient cutting. It is also advisable in most cases to make the turning tools for box-tools, from high-speed steel, especially for cutting machine steel, Norway iron, etc., because on automatic screw machine work better results are obtained by using a high peripheral velocity and a fine feed. For this reason the steel should be as hard as possible to withstand the high speed used. For brass work, a turning tool made from Styrian steel gives very good results, and is especially recommended where a high finish is desired. Turning tools made from Styrian steel are also used to a large extent for producing a smooth finish on steel work; nevertheless, it is preferable, in most cases, to use tools made from high-speed steel.

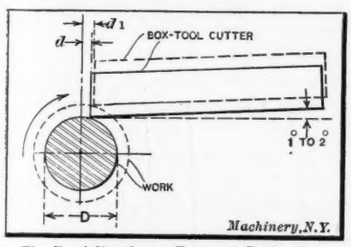

Fig. 7. Adjusting a Tangent Cutter for Turning Different Diameters

Adjusting the Tangent Cutter for Turning Different Diameters

The use of the so-called "tangent" cutter has been found to be the most satisfactory method of applying a box-tool cutter for cutting machine steel, Norway iron, etc., although this method of applying the cutter is also sometimes used for cutting brass. In Fig. 7 is shown the manner of setting a tangent cutter. The face of the cutter should be set at a distance d back of the center. This gives the tool more clearance on the periphery of the work, and is conducive to a cleaner and better cutting action. The distance d should be equal to about $\frac{D}{8}$ for tool steel, and $\frac{D}{10}$ for Norway iron and machine steel, where D equals the smallest diameter of the work being turned. The tangent cutter is adjusted in a vertical direction, and also back an amount equal to d_1, as shown by the dotted lines in the illustration. It is also sometimes advisable, especially when cutting machine steel to set the tool up from the horizontal at an angle of from 1 to 2 degrees, which increases the clearance between the tool and the periphery of the work. This is accomplished by means of adjusting screws, as was clearly illustrated in Fig. 3 of the previous installment of this article.

Sections of Steel Used for Box-tool Cutters

Box-tool cutters should not be made of too weak a cross-section, especially for roughing, although a rigid tool is also required for finishing. The conditions under which a box-tool cutter is used govern to a large extent the cross-section of the tool. For special conditions, the tool is sometimes made of rectangular section, but for standard box-tools, it is made from square stock. The square sections recommended for box-tool cutters are as follows:

Largest Diameter of Work in Inches	Square Section of Tool in Inches	Largest Diameter of Work in Inches	Square Section of Tool in Inches
$\frac{1}{4}$	$\frac{3}{16}$	$\frac{3}{4}$	$\frac{5}{8}$
$\frac{3}{8}$	$\frac{1}{4}$	1	$\frac{7}{16}$
$\frac{1}{2}$	$\frac{5}{16}$	...	..

Where box-tools are to be used exclusively for taking light finishing cuts, the sections given above can be slightly decreased.

* * *

A MONUMENTAL EDITORIAL TASK

Some interesting facts relating to the bringing out of a large encyclopedia—the Encyclopedia Britannica—were given at a dinner to the contributors to the eleventh edition of the work. It was stated that the eleventh edition will contain fifty million words, or be equal to five hundred average sized books, each of one hundred thousand words, or of nearly three hundred average book pages. All the articles have been read by the editorial staff on an average of ten times and have all been set in type in fifteen months. The great work which consists of thirty volumes is largely printed on India paper (generally known as Bible paper), and two thousand tons of this paper are required. As the normal annual output of the world of this paper is only two hundred tons, paper mills in all the chief European countries are at work producing the required amount. In the course of his address, the editor, Mr. Chisholm, stated that in dealing with industrial subjects, it has been found difficult to obtain writers who had practical knowledge, and who could also put their ideas on paper. The practical man, he said, is a great critic, and is always ready to state that matters are wrong, but it is seldom that he can explain why they are wrong, and how they can be corrected. In general, the articles of practical men had to be rewritten. Again he said that it was easy to get articles from professors, but in the past these had been distrusted, although it is true that at the present time there is a type of professor who can not only write, but who also knows his subject thoroughly from the practical point of view.

* * *

WOOD REINFORCEMENT FOR CONCRETE

Some interesting tests have been undertaken by a committee of the Institute of Civil Engineers (Great Britain) on the possibilities of reinforcing concrete with wood. At first sight it would not seem that wood could efficiently replace iron for reinforcing concrete, but there are many purposes where wood reinforcement would be satisfactory. Just as concrete with iron reinforcement tends to replace steel construction for buildings, bridges, etc., so concrete with wood reinforcement, or, as it is called, ligno-concrete, may replace ordinary bulk wood construction in many instances, as for example, in piles, posts, beams, foot-bridges, etc. It has been found that properly seasoned wood will keep intact when imbedded in concrete, and that the strength of the ligno-concrete reaches what is considered a satisfactory figure. The experiments are considered only as an entering wedge for deciding whether the matter is worthy of being investigated more fully, and the results so far obtained seem to justify more extensive research with various types of wood and concrete. The more extensive experiments have been commenced, and will be made at the East London College, England.

* * *

An effective method of fighting forest fires has been adopted by the Chicago & Northwestern Railway on its Ashland division. The equipment, as described in the *Railway Age Gazette*, consists of three tank cars and a steam pump. The tank cars have a capacity of 24,000 gallons, and are standing ready to be hurried to any point on the division, an engine constantly standing fired up in the roundhouse. This engine also supplies steam for operating the pump. A suction hose forms part of the equipment, so that water can be taken from any river, pond or tank along the road.

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Entered at the Post-Office in New York City as Second-Class Mail Matter

MACHINERY

DESIGN—CONSTRUCTION—OPERATION

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS

49-55 LAFAYETTE STREET, CORNER OF LEONARD

NEW YORK CITY

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We solicit exclusive contributions from practical men on subjects pertaining to machine shop practice and machine design. All accepted matter is paid for at our regular space rates unless other terms are agreed on.

FEBRUARY, 1911

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

SCIENTIFIC TESTING OF MACHINE TOOLS

The time to correct errors of manufacture is before the product is taken out of the factory. Obviously it costs much less to align a shaft and its bearings properly where the tools, appliances and men trained to the work are at hand, than to do it a thousand miles from the shop. It also costs less in reputation, and that is the important consideration.

But it is by no means easy to build heavy machine tools, even with jigs and fixtures provided for all the parts, so that everything will run satisfactorily from the start; nor is it possible to discover all the defects by making ordinary shop running tests. An inspection system feasible and satisfactory for light machinery will not disclose some defects of heavy tools that are likely to crop out in service. For one thing the molecular changes that take place in certain castings during their progress through the shop are not always the same. A shaft may, as a result of these imperceptible changes, be thrown slightly out of alignment; and an ordinary test might not expose the defect, which in a few weeks' use would result in a ruined bearing and a scored journal. There is, however, an infallible and simple means of discovering such defective bearing conditions when making a running test under known load, and that is the thermometer. The work done in overcoming frictional resistance is inevitably converted into heat, and the temperature rise of a bearing running under a known load for a certain period, is nearly directly proportional to the foot-pounds of work absorbed in the bearing.

Determining the temperature index and using it as evidence of the condition of all important working parts, is the basis of the admirable testing system described in another part of this number. Every important working part is subjected to a known load for a definite time, and the temperature rise is registered by thermometers and recorded by an attendant. The system of constructing speed boxes, feed mechanisms, etc., as independent units, is well suited to making such tests. The units are run independently under load and then assembled in a complete machine and run under load. During this test the temperature rise of all important parts determines the condition of these parts when working in the assembled machine.

The important and valuable feature of this system of machinery testing is that it practically eliminates the personal equation. Nothing is left to judgment or guess work. In short, it is a scientific method of securing exact knowledge of obscure conditions.

* * *

STUDY OF NEW TOOL DESCRIPTIONS

An important aspect of the new machinery descriptions published in MACHINERY, worth considering by interested manufacturers, is the study that is being made of them by students in technical schools and other institutions giving advanced instruction in machine shop practice. Although it is impracticable to keep a school shop equipped with all the very latest and best machinery on the market, the mechanical laboratory or machine shop of the up-to-date engineering school is quite a different place from that found ten years ago. Manufacturing is being conducted in the best school shops with manufacturing tools, and the students are instructed not only in the theory of machine work but also in its practice as found in the leading manufacturing plants.

To supplement knowledge of machine tool characteristics gained in the shop, systematic study is made of the new machinery descriptions published in the technical journals each month. The salient features of improved machine tool design are so clearly described in these columns that the students in practical touch with manufacturing conditions in the school shop have no difficulty in grasping the meaning and practical value of the improvements described.

The important point is that young engineers are being trained to study the characteristics of machine tools and to look to the technical journals for reliable information on the latest improvements. Hence the importance of conveying to them, as well as to the general mechanical public, clear and definite descriptions of the construction and use of the machines which they probably will have in their charge in a few years. The hearty cooperation of our manufacturers has enabled MACHINERY to do good work in this field, and our aim is to constantly improve the service.

* * *

NEW MATERIALS AND METHODS

An engineer responsible for ways and means of manufacturing a product in metal, may become so narrowed by his practice as to overlook the possibility of handling a new proposition using non-metallic materials in an entirely different way than would be best for metal. Take the case of building up a product from a material that is easily and economically punched from sheet stock with cheap dies. The practice of punching and piling is assumed to be quite correct for the material with which the manufacture was begun. Should the material be changed to a woven fabric, however, the process of punching and piling may not be the best one adapted for the manufacture of the product.

The production engineer in this situation should carefully canvass the field of manufacture, using this, to him, new material as a basis for its product, and discover if other methods of forming and assembling the desired shapes have not been developed and practically perfected. He may find that, instead of using many expensive punches and dies, for example, the economical manufacture of the product using the woven fabric should revert to simple manual methods making use of primitive tools. For instance, garment cutters cut complicated patterns with great rapidity through many thicknesses of cloth simultaneously, using a special knife of razor-like keenness. A later development is an electrically-operated cutter guided by hand which cuts rapidly through many thicknesses of cloth, but the cutting is still essentially a simple manual operation.

It was manifestly out of the question to construct dies for the great variety of shapes required in the manufacture of ready-made clothing, and the problem of cheap production was solved long ago by employing a highly skilled man who knew how to work rapidly and to maintain his tools in the required condition for efficient operation.

THE SMALL MANUFACTURER

In these days of gigantic organizations of capital and labor, the small manufacturer often feels that he is greatly handicapped in the struggle for business; but whether he really is or not depends largely on himself. In the manufacturing end of a properly-conducted, moderate-sized business the advantage lies with the small manufacturer. In the selling end the advantage undoubtedly lies with the large business. In either one, results depend more on the management of the business than on its size. The small business affords opportunities for personal oversight and economies which are impracticable in the large business; the latter affords opportunities for organization and extension which are impossible in the smaller one.

In the machine tool field there is usually a market for the very good and for the very cheap machine—one sold on its reputation, the other on its price. It is the mediocre product —neither one thing nor the other—that is hardest to sell. A choice between these two extremes should be made without hesitation; if for no other reason than because any manufacturer can turn out a poor machine, while only one can produce the best.

The best product in any field is always sure of a market. Users demand it and dealers compete for the representation—and then the selling problem is solved. There are many small makers of machine tools who turn out a product near enough the best to sell all they can make in good times; and as they started with no selling organization, the reason for success must be found in their product.

The moral is plain.

* * *

SOME DESIRABLE CHARACTERISTICS OF AN APPRENTICE

A maker of machine tool accessories, located in one of the outlying districts of Greater New York, is so situated that he is obliged to train all the mechanics constituting his working force. The experience gained in training raw material drawn from the working classes is interesting and valuable, observation showing that the boy who has the making of a careful and thoroughgoing mechanic quickly displays the characteristics necessary for a good workman. The manufacturer referred to watches his boys and notes carefully whether or not they display any inclination to acquire the tools needed by a machinist in working at his trade. The boy who is content to go on day after day using tools borrowed from the tool-room or from his shop mates is put down as being N. G. It is considered that he has no real interest in what he is doing, but is simply working at that trade because it happened to offer an opening.

On the other hand, the apprentice who early provides himself with calipers, squares, micrometers and other small tools commonly found in a mechanics's tool-box, displays one of the characteristics that are necessary for success. Naturally it does not follow because a man or boy has a fine box of machinist's tools that he is or will be a good workman, but it indicates an interest in his work that is encouraging, and the chances are that, given early opportunities, such a workman will turn out well.

* * *

THE ADVANTAGE OF MEMORIZING SIMPLE FORMULAS

Under "Letters on Practical Subjects" in this number of MACHINERY, a contribution appears relating to a shop calculation for determining the diameter of a bored hole that is afterwards to be threaded. This simple calculation, and the method by which a machinist in the shop was able to quickly determine, without the aid of tables, the necessary amount to leave for any required pitch of thread, illustrates forcefully the usefulness of carrying a few simple formulas and constants in the memory. Many tables of formidable size are based upon, and calculated from, a formula of the very simplest kind, containing a constant which can be easily memorized. A great deal of time is frequently wasted in searching for a specific table giving the constant to be used in a particular shop calculation; and the memorizing of a few formulas and constants would save considerable time in many instances. Besides, it is a satisfaction to be able to go ahead without continually referring to handbooks and tables for the simple formulas and constants in almost daily use.

It is also extremely useful to the mechanical man, whether he be an engineer or machinist, to know how the formulas which he uses in his calculations are derived. If he does know, he is able to deduce a formula which may have been forgotten, and which he cannot find in a handbook at the time he needs it. It is said of Lord Kelvin that he seldom remembered the formulas he used in engineering calculations, but derived them each time, going through the mental processes of each calculation from the beginning. This, of course, would be a waste of time in the engineering office or the shop, but it is of importance for the successful mechanic to know how to arrive at a formula which he uses frequently in his work, if an occasion arises when the memory fails or leaves him in doubt. The handbooks are not always within reach, and while they are extremely useful, it is a good practice to train oneself not to depend entirely upon them for the simplest kind of information.

The substance of what has been said may be stated as follows: Memorize as many formulas and constants as can be conveniently carried in the head, and master their derivation whenever possible.

* * *

RESTRAINED COLUMN FORMULAS

That the stresses in the wall of a tube exposed to external fluid pressure are of the same character as those in a column having the ends fixed in direction, is the conclusion drawn by Professor Reid T. Stewart, in a paper on, "Stresses in Tubes," delivered before the January meeting of the American Society of Mechanical Engineers.

Using the experimental results for the collapsing pressures of commercial steel tubing from 3 to 12 inches in diameter which he had previously obtained, equivalent column formulas were derived upon the assumption that the circumferential stress in a tubular annulus subjected to external fluid pressure is theoertically the same as in a straight column with fixed ends whose length is one-half the mean cicumference of the tubular annulus.

The results of the investigation were that

$$S = 42{,}640 - 127.4\frac{l}{r}$$

for values of $\frac{l}{r}$ less than 221, and

$$S = 25{,}105{,}000 \times \frac{1}{\left(0.1838\frac{l}{r} + 1\right)^2}$$

for values of $\frac{l}{r}$ greater than 221. This latter formula may be represented with sufficient accuracy for all practical purposes as follows:

$$S = 708{,}000{,}000\left(\frac{r}{l}\right)^2$$

In these formulas: S denotes the axial load on equivalent column, l, the length of equivalent columns, *i. e.*, half the mean circumference; and r, the radius of gyration of the column cross-section. The fraction $\frac{l}{r}$ is the slenderness factor.

* * *

An interesting and apparently rational explanation of the thunder accompanying lightning is given in *Nature* by Herr H. L. Braun. According to this explanation the electricity discharged between two clouds or between a cloud and some object on the earth decomposes the small particles of water in the atmosphere into its constituents. The hydrogen and oxygen thus produced are mixed mechanically and form an explosive mixture which is immediately ignited by the heat of the flash, and when exploding produces the characteristic rattling report of thunder.

SHELL TURNING OPERATION IN THE HARTNESS FLAT TURRET LATHE

By FRANKLIN D. JONES*

At the Edison Works in Orange, N. J., a great many "mold shells" similar to the one illustrated in Fig. 1 are employed. These shells must be accurately finished to a slight taper, both inside and out, threaded and plain recesses are required at the ends, and, in addition, one or two minor operations are necessary, so that their manufacture on an efficient basis is an interesting example of turret lathe practice. This work is done in the Hartness flat turret lathe, built by the Jones & Lamson Machine Co., of Springfield, Vt.

The shells are turned from cold-drawn seamless steel tubing, having a carbon content of 0.20 per cent, and they are finished at the rate of one in nine minutes. The tubing comes to the machine in 12-foot lengths, and the tube being operated upon, is, of course, fed forward through the hollow spindle as each successive shell is severed. In finishing this shell, five different operations are required. During the first operation the shell is rough bored and turned by one passage of the box-

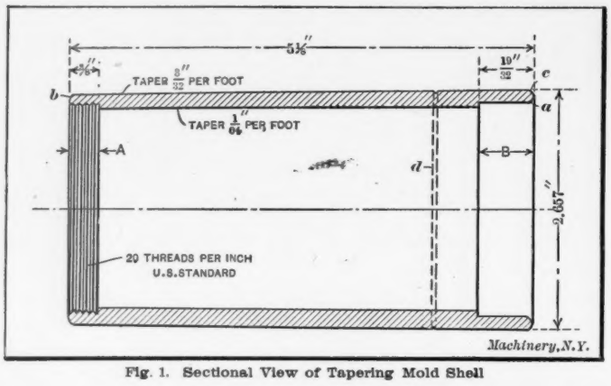

Fig. 1. Sectional View of Tapering Mold Shell

tool, Fig. 2, and the recess *A*, Fig. 1, at the outer end, is finished to size by a second cutter located in the boring-bar close to the turret. The turret is then indexed to the second station which brings the threading attachment *G* into position, as shown in Fig. 3. After the thread is finished, the recess *B*, Fig. 1, is turned by a flat cutter *K*, Fig. 4. The inner and outer surfaces are then finished to size by a box-tool mounted on the fourth station of the turret and shown in position in Fig. 5. The final operation, Fig. 6, is performed by three tools

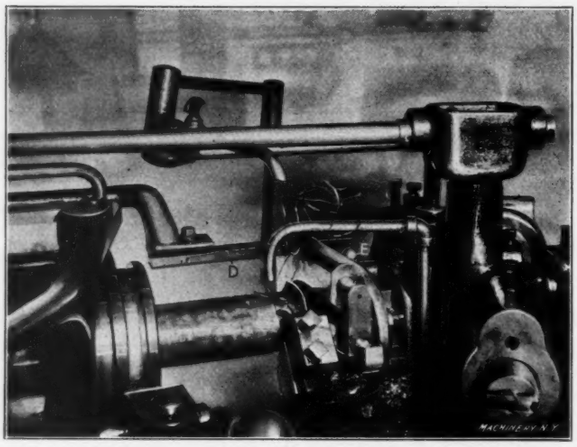

Fig. 2. First Operation on the Mold Shell—Rough Turning and Boring

on the turret cross-slide, and consists in rounding the corners at *b* and *c*, Fig. 1, and severing the finished shell.

One of the interesting features connected with the machining of this shell, is the finishing of the inner and outer tapering surfaces. The taper on the outside is 3/32 inch per foot, while the bore has a taper of only 1/64 inch per foot, and these surfaces are finished simultaneously, with practically no special equipment. The box-tool employed is of a standard type, with the exception of an inserted boring-bar, and the taper on the outside is obtained by the regular attachment which consists of a templet *D* (Fig. 2) of the required taper, that causes the turning tool to recede at a uniform rate as it traverses. To secure the internal taper, the headstock of the machine is swiveled slightly on its transverse ways by the use of tapering gibs. By this simple method, the double taper is finished

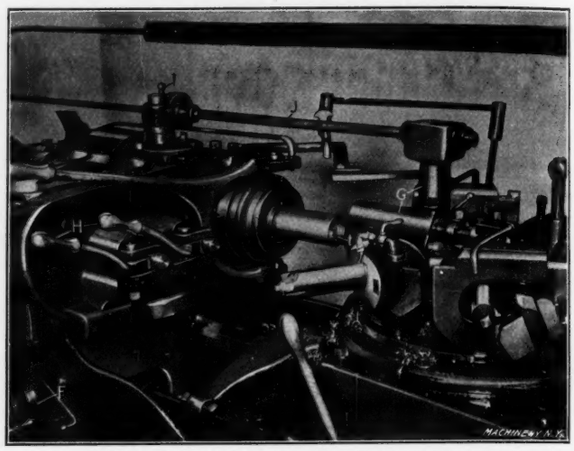

Fig. 3. Second Operation—Cutting Internal Thread

to the required accuracy without special tools or equipment.

As those familiar with this machine know, the longitudinal movements of the turret as well as the transverse movements of the headstock are controlled by positive stops. The headstock has ten stops which are mounted in a revolving holder and are brought into position, as required, by manipulating a lever at the front. The stops for length, or those controlling the turret travel, are divided into two general groups, known as "A" and "B." Each of these groups has six stops so that

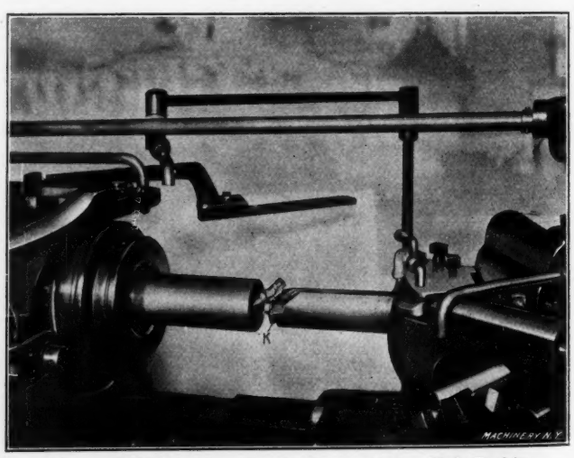

Fig. 4. Third Operation—Turning Recess at Rear End; Tool is shown withdrawn

there are two stops for each of the six positions or stations of the turret, and, in addition, five extra stops are available for any one tool, by the engagement of a pin at the rear of the turret. The change from the "A" to the "B" stops is made by adjusting lever *L*, Fig. 5, which also has a neutral position.

After the box-tool for the roughing cut, shown at work in Fig. 2, has reached the end of its travel, further movement is arrested by a stop of the "A" group. The outside turning tool is then withdrawn by operating lever *E* and the turret is run back and indexed to the second station, thus bringing the threading attachment into position. The surface speed of 130 feet per minute which is used for turning is reduced to about 30 feet per minute for threading by manipulating levers *H*, Fig. 3. After the turret is located by another stop of the "A" group, the threading attachment is made operative by depressing a small plunger *I*, which connects a vertical driving shaft from the spindle with the splined transmission shaft *J*. A reciprocating movement is then imparted to the thread chaser *t* which advances on the cutting stroke and then automatically

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retreats to clear the thread on the return. This movement is repeated until the thread is cut to the proper depth, as determined by one of the stops for the headstock. While the thread is being cut, the carriage is locked to the bed by the lever *N*, Fig. 5. It was found necessary to perform the threading operation before taking the outside finishing cut, owing to a slight distortion of the shell wall, caused by the threading operation. After the thread is finished, the turret is turned to the third station as shown in Fig. 4, and tool *K* for the inner recess *B*, Fig. 1, is brought into position and fed to the proper depth, as determined by another cross stop. The turret is also locked in position for this operation. The finishing cuts for the bore and the outside are next taken by a box-tool which is

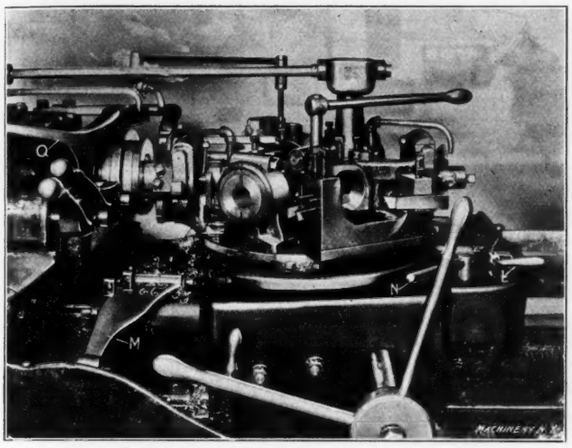


Fig. 5. Fourth Operation—Finishing the Bore and Outside

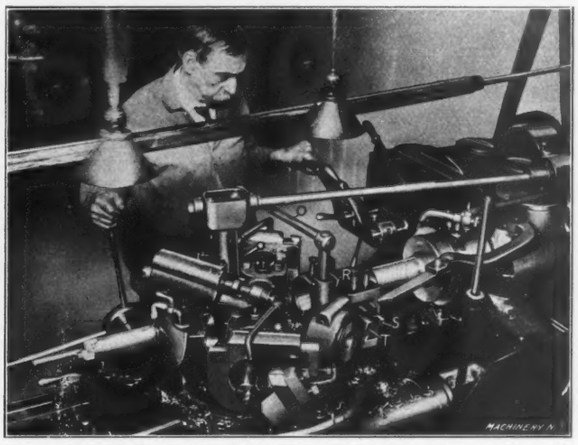


Fig. 6. Fifth Operation—Rounding Ends, Scoring Large End, and Cutting Off

shown near the end of its cut in Fig. 5. This box-tool is similar to the one used for roughing, but it is equipped with differently shaped cutters to obtain the required finish. The outside turning tool has a straight cutting edge set tangent to the cylindrical surface and at an angle, while the boring tool has a cutting edge of large radius. An end view of this box-tool is shown in Fig. 6. A reduced feed is employed for the finishing cut, which is obtained by turning the feed variator *F*, Fig. 3, and the speed is increased to 130 feet per minute, which is the same as that used for roughing.

During the next and final operation, the turret, after being indexed to the position shown in Fig. 6, is first located by a stop of the "A" group so that the cutting-off tool *R* in front can be used for rounding the corner *b*, Fig. 1. The stop lever *L* is then shifted and the turret is moved to a second stop of the "B" group. The corner *c* is then rounded and the shell is scored at *d* by two inverted tools *S* and *T* at the rear, after which the finished work is severed by the cut-off tool at the front. The cross movement of these three tools is controlled by positive stops on the cross-slide, and the latter is moved to and fro by hand lever *O*. After the shell is cut off, the stop *M*, mounted on the turret, Fig. 5, is swung into position, and the tube is automatically fed forward to the swinging stop by the roll feed, as soon as the chuck is released by operating lever *Q*. This completes the cycle of operations. A copious supply of lubricant is, of course, furnished to the tools during these operations, and the two boring-tool shanks are hollow so that lubricant can be forced through them and be made to play directly upon the cutters.

The gages for testing the accuracy of the finished shell are illustrated in Fig. 7. At *A* the over-all length gage is shown in place on a finished shell, while at *B* and *C*, respectively, are the "go" and "not go" gages for the recesses at the ends of the shell. These recess gages also check the depth of the counterbored part. At *D* is the thread gage, and at *E* the internal and external taper gages—the one being an ordinary plug gage and the other the straightedge type of external taper gage. Both these gages have limit marks and are used for testing both diameter and taper. When a shell is being tested in the external gage, it is located in a central position laterally, by two contact pins in the rear, and the taper must be sufficiently true to prevent daylight being seen between the work and the straightedge.

* * *

At a public lecture in Manchester, England, on November 18, Mr. Joseph Clarkson gave a demonstration with a flying-machine model 8 feet in diameter, provided with a new form of propeller of his own invention. This invention is intended to solve the problem of vertical and slow flying. As described in *Engineering*, various weights were attached to the frame of the model, and the propeller, which was driven by an electric motor, was made to revolve. As soon as it attained the required speed, the model rose gently vertically from the floor until it reached a stop which had been provided for preventing its rising too high in the room. After having remained in this position for a short time the speed of the motor was slightly reduced, and the model descended slowly until it came to rest almost silently, on the floor. In another test it was shown hovering in the air, neither rising nor falling. The energy used for lifting 12½ pounds vertically and maintaining it in the was 0.4 horsepower, the revolutions per minute being only 53. The inventor calls his device the "aerocar." A full-sized model would have four propellers, two on each side of the car. When the aerocar has risen sufficiently, some of the power may be used for forward or reverse movements.

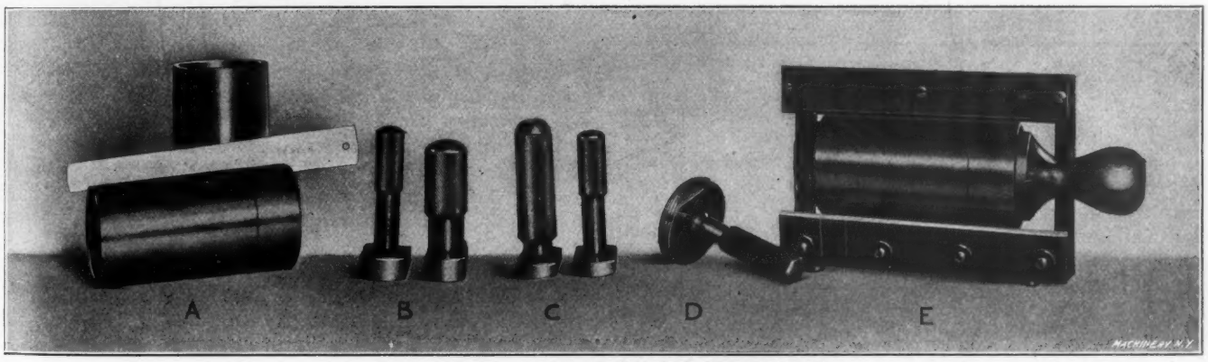


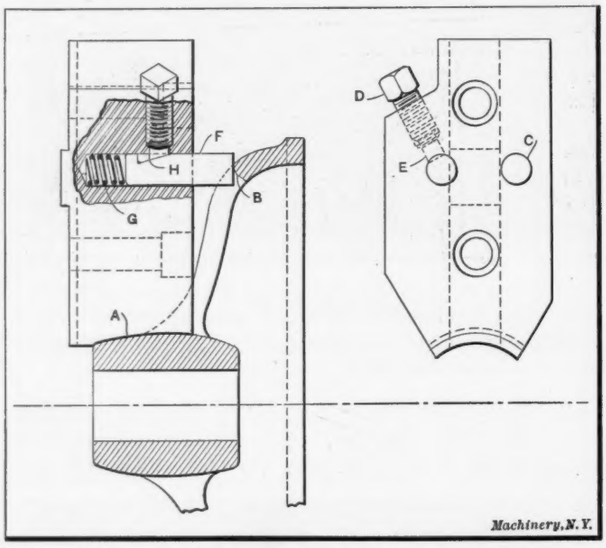
Fig. 7. Gages used for Testing Accuracy of Finished Shell

LATHE CHUCK JAWS*

By FRANK H. MAYOH†

When we take up the question of rapid production, we meet with the necessity of having an effective method of holding the work while operating upon it. The method to be used is always governed by the shape of the work, the material from which it is made and other requirements. The main requirements are that a very rigid method of holding should be adopted, so that the work will not slip or slide while it is being operated on. This generally necessitates the scoring of the face of the chuck jaws, which enables them to get a better grip on the work. As a rule, for rough material such as iron castings, etc., it is advisable to harden the faces of the chuck jaws and also have them scored; but when holding work which has a finished surface it is preferable to leave the jaws soft. Having the jaws soft also has the advantage of enabling them to be trued up when they become sprung or bruised.

The writer's aim in the accompanying data sheets has been to present a number of different chuck jaws which are used



Holding a Handwheel with Chuck Jaw shown in Fig. 9 of Data Sheet Supplement

for ordinary work. Of course, with slight modifications, jaws of the description given could be used for special conditions. The type of chuck jaw shown in Fig. 1 is that which is usually supplied with standard lathe chucks. This type of jaw is generally made so that it can be inverted, thus making it adaptable for both external and internal work. This evidently increases the value of these jaws in making them adaptable for a wide range of work.

Fig. 2 is a type of chuck jaw which is sometimes used when it is necessary to have the work pass into the spindle. These jaws are usually made with a hard and soft end, so that they can be used for both rough and finished work. Fig. 3 shows a type of jaw which is somewhat similar to Fig. 2, but differs in that it has a shoulder *A* which acts as a stop for the work. The principal advantage of this type of jaw, is that it can be used for facing the work to length, as well as for numerous other operations.

Fig. 4 shows a type of jaw which is principally used for holding bevel gears, piston rings, etc. The rings are made from long castings which have a tapered portion on one end which is gripped in the chuck. This necessitates that the shape of the jaw should conform to the tapered portion on the end of the casting.

It is sometimes found necessary to take a cut up close to the chuck which necessitates the toolpost being in close proximity to it. For this class of work the chuck jaw is cut away as shown at *A* in Fig. 5, so that the jaws will clear the toolpost. Fig. 6 shows a jaw somewhat similar to Fig. 5, but its use is principally for gripping under the flange of pulleys, or work of similar character, and it has its gripping portion scored to prevent the work from slipping. This type of jaw is usually hardened on its gripping portion. Another advantage of this jaw is that it facilitates the complete machining of a piece of work—for example, a pulley, as both edges of the rim may be turned, the hubs faced and the hole bored all in one chucking.

A type of jaw which enables us to grip a piece of the full capacity of the chuck is shown in Fig. 7. This jaw is used for gripping a large variety of work such as flywheels, etc. In order to get as much of the work as possible into the chuck, or furnish a more substantial drive, as would be sometimes necessary in turning a pulley, the chuck jaw is made as shown in Fig. 8. Here the jaw is slotted at *B* so that it straddles the arm; the jaw is also cut out at *A* so that a back facing tool may be used, thus enabling the facing of both faces of the hub in one chucking.

In Fig. 9 is shown a chuck jaw which is a little out of the ordinary. The main feature of this jaw is its adaptability to holding rough castings such as handwheels. The accompanying illustration shows this type of jaw (Fig. 9) applied to holding a handwheel. In operation, the hub *A* of the handwheel is gripped in the jaw, as shown, and the web is placed against the stop-pin *C*. The lathe is then rotated and the casting trued up. If it is found that the casting runs out much, it is trued up in the following manner: The spring-pin *F*, which is opposite the low spot is released by loosening the set-screw *D*, and forced out by spring *G*, after the casting has been knocked out. The set-screw *D* presses upon a shoe *E*, which is tapered to correspond to the tapered portion *H* on the spring-pin, so that the pressure of the cut will not force the pin back to its former position.

The type of jaw shown in Fig. 10 is for special cases which are not met with very frequently. Usually this type of jaw is used for gripping a curved hub, but when used for this class of work, the jaw should be sharply scored, in order to prevent the work from being forced out of the jaws when screwing them down. As a rule this type of jaw should be avoided. When gripping a long piece of work having one or more different diameters, we frequently find that it would not be sufficient to have the jaws just grip on one diameter. For this class of work the jaws shown in Fig. 11 are used, which obviates the trouble mentioned.

One class of work which is very difficult to hold is long rough castings, and if the ordinary type of jaw is used for this work it is usually a difficult job to get the casting to run true near the jaws and also at the outer end. For this kind of work the type of jaw shown in Fig. 12 is recommended. The jaws are cut away at *A* and slotted at *B*, which gives a four-point bearing. This holds the work very effectively, and enables it to be trued up with less trouble.

Fig. 13 shows the type of jaw which is commonly used for holding bevel gears of large diameter. The gripping part of this jaw is made to conform to the bevel on the gear. A suitable jaw for holding spur gears which are made with arms is shown in Fig. 14. This jaw is beveled at *A*, so as to fit in between the arms, and is also grooved at *B* to straddle the web. Holding a spur gear in this type of jaw, enables it to be finished in one operation, as the rim can be faced and turned, the hole bored and both sides of the hub faced.

Fig. 15 is used for holding gears or other work finished in one operation, and which is beveled on the inside of the rim, as is usually the case with most gears. The angle on the jaw is made very slight and a groove is cut as shown. This jaw should also be sharply scored and hardened.

When machining cast gears it is sometimes found a difficult proposition to prevent the gear from turning against the cut until the scale is removed. For this class of work, when convenient, a driving pin *A*, as shown in the jaw in Fig. 16, is sometimes used. This pin fits in a tooth space, avoiding the necessity of screwing the jaws down excessively tight on the work to prevent it from slipping.

No attempt has been made in this article to describe the means of attaching the jaws to the chuck. The universal

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LATHE CHUCK JAWS—I

Fig. 1. Chuck jaws usually supplied with lathe chucks. The chief value of this type of jaw lies in its adaptability to a large range of work.

Fig. 2. For gripping plain bushings when machining in two operations: First grip rough part with hard end of jaw, then reverse jaw and grip finished part with soft end of jaw. This type of jaw is also used when it is necessary to have the work pass into the spindle.

Fig. 3. For holding work which is to be faced to length. The shoulder A acts as a stop for the work. These jaws are made with either hard or soft ends.

Fig. 4. For holding piston rings or similar work. The piston rings are made from long castings and are tapered on one end, which is gripped in the chuck. The jaw is made to conform to the tapered end on the casting.

Contributed by Frank H. Mayoh

No. 139, Data Sheet, MACHINERY, February, 1911

LATHE CHUCK JAWS—II

Fig. 5. For holding work where it is necessary to have the toolpost come close to the jaws. The jaws are cut back at A for clearance.

Fig. 6. For gripping under a flange. These jaws are made to conform to the shape of the work and are scored.

Fig. 7. "Hook" jaw for increasing the capacity of the chuck; used principally for gripping fly wheels, etc.

Fig. 8. For holding pulleys, etc. The jaws are cut out at A to permit back facing the hub, and are slotted at B to straddle the arms.

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LATHE CHUCK JAWS—III

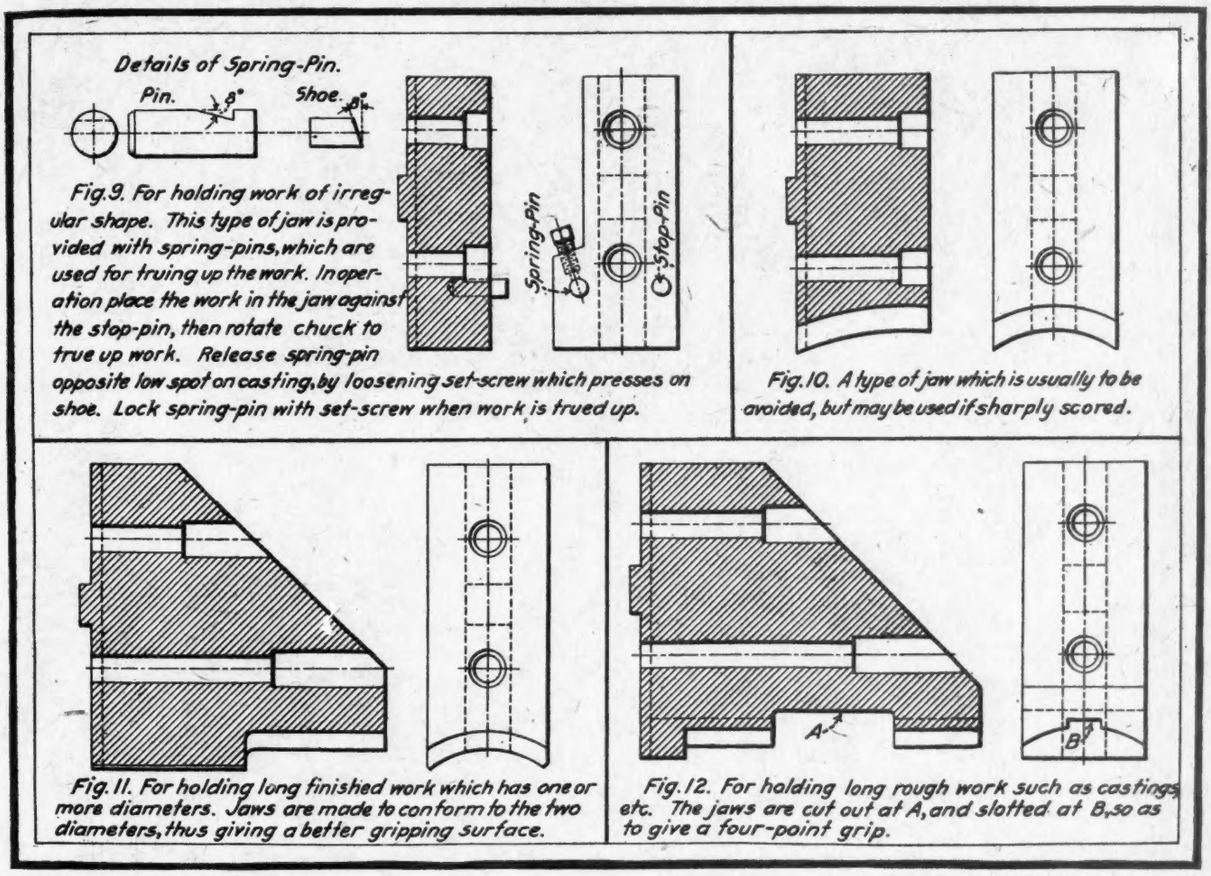

Fig. 9. For holding work of irregular shape. This type of jaw is provided with spring-pins, which are used for truing up the work. In operation place the work in the jaw against the stop-pin, then rotate chuck to true up work. Release spring-pin opposite low spot on casting, by loosening set-screw which presses on shoe. Lock spring-pin with set-screw when work is trued up.

Fig. 10. A type of jaw which is usually to be avoided, but may be used if sharply scored.

Fig. 11. For holding long finished work which has one or more diameters. Jaws are made to conform to the two diameters, thus giving a better gripping surface.

Fig. 12. For holding long rough work such as castings, etc. The jaws are cut out at A, and slotted at B, so as to give a four-point grip.

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LATHE CHUCK JAWS—IV

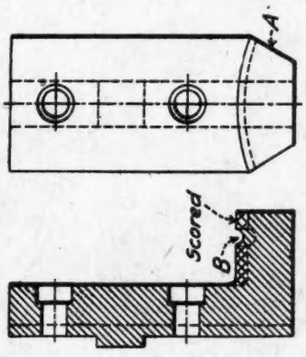

Fig. 14. For gripping between the arms, and under the rim of gears, pulleys, etc. The jaws are beveled at A to conform to the angles of the arms, and cut out at B to straddle the web.

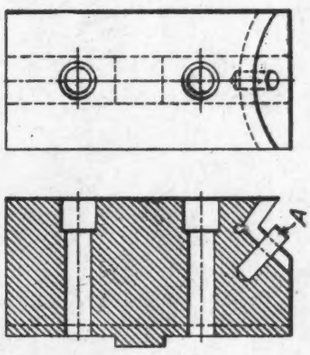

Fig. 16. For holding cast bevel gears. The jaws are made to conform to the bevel on the gear, and the pin A is used for driving, being engaged in a tooth space.

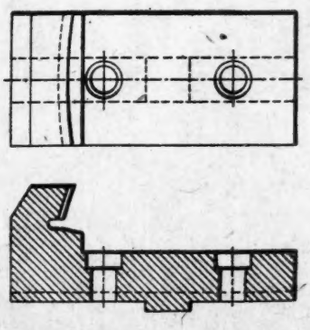

Fig. 13. For holding bevel gears, etc. The jaws are made to conform to the bevel on the gears.

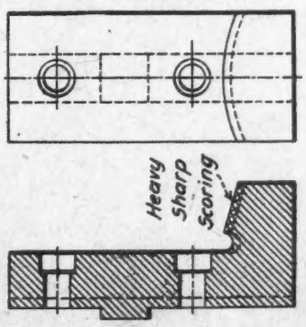

Fig. 15. For holding bevel gears, etc. which are finished in one operation. The jaws are made with a slight angle and are scored.

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method at present is to form a tongue on the jaw which fits into a corresponding groove cut in the members that are operated by the adjusting screws. Making the jaws in this manner insures their interchangeability, so that different jaws can be used for holding various classes of work.

* * *

COMMON DEFECTS IN METAL ALLOYS*

The knowledge of the properties of non-ferrous metals and alloys has not developed as fast as that of iron and steel. Several causes have contributed to produce this condition. The number of industrial metals and alloys is so large, and their characteristic properties so diversified, that conclusions arrived at from a study of one group would be of little or no value when applied to another.

Many difficulties are met with when using alloys in practice. Some of these are inherent, but some could be avoided by careful treatment. It frequently happens that a perfectly satisfactory alloy fails because of being subjected to entirely unreasonable heat treatment or to mechanical stresses, in the course of being fitted for use. Such treatment is applied in ignorance of the effect likely to be produced, but considering the care that is taken in handling steel, it is remarkable that non-ferrous alloys are often treated as if they were mere inert material, which might be ill-treated without suffering any injury. For instance, while no user of metals would quench steel from high temperature or submit it to prolonged annealing without reference to the purpose for which it was to be used, it is not an uncommon experience to find bronzes made for special purposes treated in such a way.

There are eight distinct classes of defects commonly found in alloys used in machine building. These defects may be classified as: 1. Sponginess; 2. Brittleness; 3. Defects due to inequalities of composition; 4. Excessively coarse structure, due to casting at too high a temperature; 5. Defects due to wrong thermal treatment; 6. Defects due to molecular change other than that produced by mechanical stress; 7. Shrinkage cracks; and 8. Defects due to mechanical deformation.

1. *Sponginess.*—This is caused by gases dissolved in the molten metal or alloy, which are released at the moment of solidification. This defect is aggravated by over-heating the metal, and may be remedied by re-melting it and pouring it at the proper temperature.

2. *Brittleness.*—This may be caused by oxides or dross due to lack of care in pouring, or to over-heating, which causes burning, as in the case of the zinc alloys. The oxides of different metals vary as to their ability to separate themselves from the liquid and rise to the surface, and various deoxidizers are used to facilitate their removal in the form of slag. A second source of brittleness is the presence of thin layers of non-homogeneous alloys between the crystals. The microscope is of great assistance in studying cases of this kind.

3. *Defects due to inequalities of composition.*—These defects are due either to improper mixing of the ingredients, to separation by gravity during solidification, or to segregation in the mold. When the ingredients are not uniformly mixed, the usual cause is the difference in specific gravity of the ingredients. Aluminum, for example, tends to float, and lead to sink. Certain metals, particularly aluminum, also possess the property of becoming enclosed in a film of oxide as soon as in the molten state, while others have an action similar to that of oil and water and must be stirred to an emulsion and then carefully cooled to prevent separation. With alloys of tin and antimony, or mixtures containing them, a difficulty is met with in that crystals of tin and antimony form and float upward. This tendency is overcome by rapid chilling. Impurities in general, such as lead and bismuth in bronzes will accumulate at the center of the parts and cause unsound castings.

4. *Excessively coarse structure due to casting at too high a temperature.*—As the strength of an alloy depends upon the degree of adhesion between neighboring crystals, as well as upon their size, and as these qualities in turn depend on the casting temperature and the degree of chilling, this becomes a complex question that requires much further investigation. A few alloys containing copper and zinc, and especially those rich in zinc, have an extraordinary tendency to form large crystals having little mutual adhesion.

5. *Defects due to wrong thermal treatment.*—These defects are due to a number of causes, as for instance, to quenching from too high a temperature; heating at too high a temperature or too long during annealing; burning, as in the case of copper and zinc alloys; and unequal thermal treatment of different parts of the same casting and forging. The principal effect of wrong thermal treatment is the production of coarse structure in alloys in general, and a hard, brittle metal in most bronzes. Unequal treatment also produces differences in the structure in different parts of the alloys.

6. *Defects due to molecular changes other than those produced by mechanical stresses.*—Some metals undergo changes at definite temperatures which involve a complete alteration of their properties. The most striking instance is that of tin, which may pass spontaneously into a gray powdery substance devoid of mechanical strength, at a low temperature. Many alloys have been known to disintegrate spontaneously from no known cause. Some of the alloys of aluminum with other metals fall to powder after a time, while an alloy of 80 per cent of aluminum and 20 per cent of tin breaks up into coarse crystals. It may be that these phenomena are due to impurities in the constituents. This is indicated by the behavior of alloys of copper and manganese which have been described as disintegrating spontaneously. When prepared from pure metals, however, these alloys are permanent, and the disintegration is entirely due to the presence of non-metallic impurities.

7. *Shrinkage cracks.*—These may be due to a poor arrangement of the mold, to wrong casting temperature and to the great brittleness of the alloy at a temperature just below that of solidification. The latter condition is the cause of the great tendency of aluminum-zinc castings to crack during cooling.

8. *Defects due to molecular changes produced by mechanical deformation.*—These defects show themselves as brittleness in cold worked metals; "season-cracks" in brass and other alloys which become visible some time after rolling; and "fire-cracks," which differ from the foregoing only in that they appear during the annealing process alone. It is said that fire-cracks never appear in pure metals, but always in alloys. German silver is particularly liable to this defect. "Chilling-cracks" are produced when metals are suddenly quenched. Cracking is also due to hot working, as most alloys show an increased brittleness at some particular temperature. Many bronzes have only a small range of temperature within which they may be safely worked. This subject has as yet been but imperfectly investigated.

In addition to the defects mentioned, there are some defects which arise in the course of the use of alloys, and which do not fall under any one of the above heads. These defects are due to corrosion and erosion. The question of corrosion of alloys is now being investigated by a committee of the Institute of Metals (Great Britain), because as yet but little data has been collected on this subject. The conditions which affect the liability of alloys to mechanical erosion also demand further study. An interesting case of erosion is that of high-speed propellers acted upon by eddy currents in the water. In some cases the propeller blades are eroded to a depth of as much as 1½ inch in the middle of a blade, while the remainder of the blade is perfect. It appears that different bronzes behave very differently in regard to this action. A definite relation between the microscopic structure and the liability to erosion yet remains to be established.

* Paper read by Dr. C. H. Desch, before the Glasgow meeting of the Institute of Metals, September, 1910.

* * *

A "non-stop run" of sixteen days and nights was made during the Texas State Fair at Dallas, last October, with a $600 Maxwell runabout. The car covered, during sixteen days, 3162 miles, much of the driving being done through crowded streets.

STOCK-KEEPING

By S. M. HOVIS

In all manufacturing establishments the place in which the most money can be lost or saved is undoubtedly the stock room; for here in one department, we find all the parts comprised in the product, the smaller tools used in its making, and in some cases expensive printed and advertising matter. Yet, in nine cases out of ten, this department is placed in some poorly-lighted, ill-ventilated, obscure part of the building in charge of a man who has probably secured the position in consequence of a good memory or his inability to become a me-

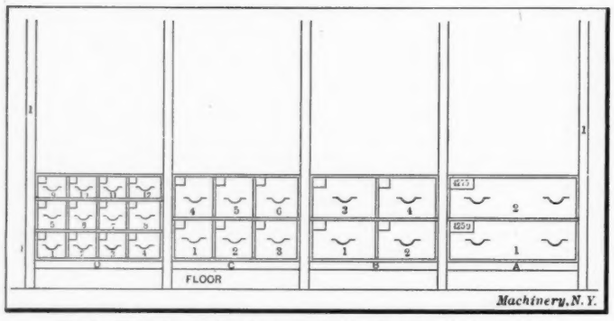


Fig. 1. Elevation of the Arrangement for Keeping Parts, used by a Company Manufacturing Small Machines

chanic, and who is very frequently incompetent or worse, probably due to his being very much underpaid. As assistants, there are usually with him a few boys or old men who cannot be usefully employed in other departments.

The system of stock-keeping submitted in this article has been tried in various plants and proved to be very successful, not only from a production, but also from a pay-roll standpoint. It must be understood, however, that the success of any system depends largely on the cooperation of the office and accounting departments with the stock-keeper, and any error or misunderstanding between them should be investigated and settled at once; for frequently, even in the best managed plants, the office is obliged to call on the stock-keeper for information, and his prompt attention facilitates matters.

In a properly systematized plant all the parts entering into the final product should be kept in the stock room and drawn

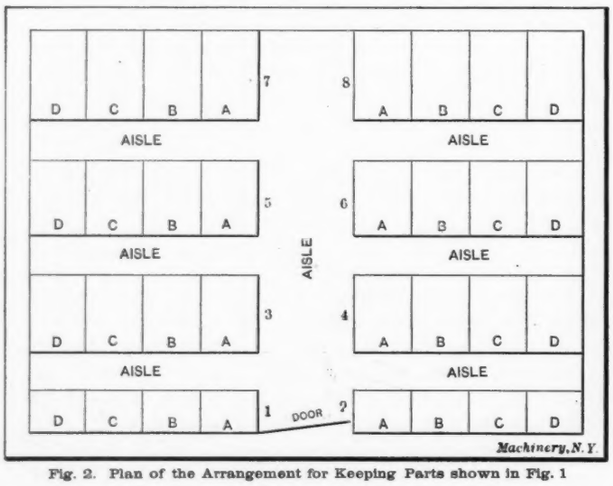
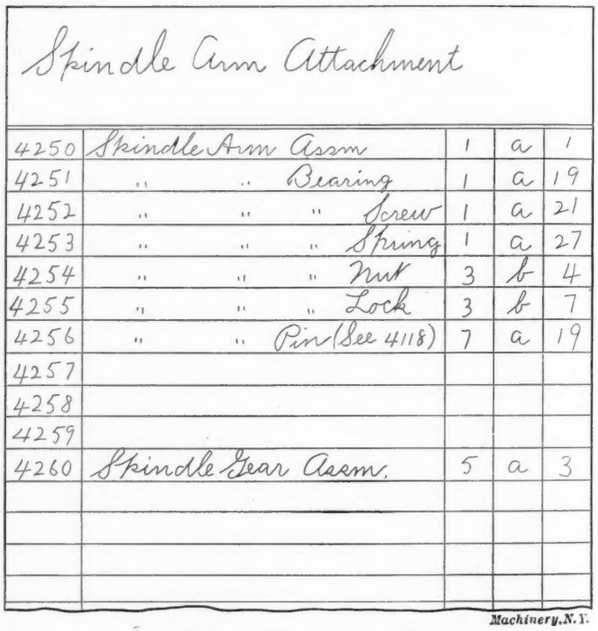


Fig. 2. Plan of the Arrangement for Keeping Parts shown in Fig. 1

out as desired on orders signed by the proper authority, usually the foreman of the department concerned. This stock may be divided into three classes: finished stock, rough stock and supply stock. Under the classification "finished stock" are included all the parts which are manufacured in the plant. The rough stock includes all purchased materials such as steel, iron, rough castings, etc. Supply stock constitutes such materials as paint, waste, oil, small tools, etc., and at times includes such things as advertising matter, letter-heads, envelopes and office supplies. The first-mentioned of these supplies are frequently included under the "rough-stock" head, but experience shows that by keeping these supplies under a separate heading, better accounting results may be secured. These divisions, of course, may be varied to suit the requirements of the accounting department, but in most cases these three divisions will be found to be sufficient.

It cannot be too forcibly stated that every article in a stock room should be known by a number in addition to its name, and wherever possible that number should appear on the requisition for material. In good manufacturing systems the use of names for parts may be entirely eliminated, numbers being used exclusively, the result being better and quicker service in the filling of orders. The use of letters in designating material, except where absolutely necessary, is to be avoided, although in some cases a letter is placed before or after a number to show the kind or quality of the material. As for example 211A might mean casting; 642B forging; and so on, although a system of numbering may be devised that is equally effective. For instance in a case where the product is a machine consisting of a number of minor assemblies, all numbers ending in 0 would designate an assembled part; 01 a screw; 03 casting, and so on. By such an arrangement a


Spindle Arm Attachment

4250	Spindle Arm Assm	1	a	1
4251	" " Bearing	1	a	19
4252	" " " Screw	1	a	21
4253	" " " Spring	1	a	27
4254	" " " Nut	3	b	4
4255	" " " Lock	3	b	7
4256	" " Pin (See 4118)	7	a	19
4257				
4258				
4259				
4260	Spindle Gear Assm.	5	a	3

Machinery, N.Y.

Fig. 3. Portion of a Parts List

parts-list may be made up and mastered after a little study.

The center of the building seems to be the preferred position for the stock room, but the ideal location is at the end of the building, as near the office as possible, for in the former case a considerable drawback arises should it ever become necessary to enlarge this department, as other departments would be more or less inconvenienced. Furthermore, firmer and better structure for holding material may be built at the end of the building.

No drawers or shelving for parts that are in constant use should be more than seven feet above the floor, the space above this being utilized for such parts as are only occasionally called for. In so arranging the parts that they may be readily located, an indexing system has been devised which with slight variations may be suited to any special business. Fig 1 shows the front view of an arrangement used by a plant manufacturing a number of small machines. This room which is about forty feet square is divided through the center by an aisle four feet wide and is sub-divided into sections, tiers, and compartments. The term *section* is applied to the construction on either side of the aisle, that on the right being designated by even numbers and that on the left by odd. These sections are divided into *tiers* which represent spaces between the uprights and are alphabetically lettered to avoid the confusion of numbers. The *compartments* are the drawers or shelving for hold-

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ing parts. Figs. 1 and 2 give a general idea of the application of this plan.

Sheet iron or heavy tin is the most practical and durable construction material for drawers, especially for those holding parts which are oiled. These, with a small card-holder and handle, may be obtained at low price, and being easily washed and lighter than wood, facilitate handling. In addition they should be made interchangeable, the tiers being fitted with strips to hold interchangeable boards upon which the drawers can rest. In drawers that are the same width as the tiers

STORES ORDER

ORDER NO. 1437

DELIVER TO 110 DEPT. H DATE 7/2/10 LOT NO. 2

QUAN	DESCRIPTION	NO.	COST PER UNIT	COST TOTAL
100	Parts to Assemble	4250		

FILLED BY 616 | CHECKED BY 712 | O'N' STOREKEEPER Smith | FOREMAN Brown

Machinery, N.Y.

Fig. 4. Stock Requisition Slip

(see Fig. 1, 1A1 and 1A2), these strips may be fastened to the sides and will be found to work very satisfactorily if proper dimensions are used.

The arrangement for taking care of the stock having thus been attended to, the application may next be noted. Fig. 3 shows a section of a page of a parts-list in common use. A requisition calls for part 4250 which is shown in parts-list as being located in section 1, tier A, drawer 1 (1A1.) The stock clerk knows that 1 being odd, is located to the left of the main aisle; A being the first letter of the alphabet, is the first tier of section 1; and drawer 1 will be at the bottom of a tier. One company, in mind at present, has its product divided into sections, parts for which are drawn out, assembled and then

Spindle Arm Assm. 4250

PART	QUAN	NAME	SEC	TIER	COMP
4251	1	Spindle Arm Bearing	1	a	19
4252	2	" " " Screw	1	a	21
4253	2	" " " Spring	1	a	27
4254	1	" " " Nut	3	b	4
4255	1	" " " Lock	3	b	7
4256	2	" " " Pin (4118)	7	a	19
4257	1	" Gear Assm	5	a	3

Machinery, N.Y.

Fig. 5. Stock-keeper's Location Card

returned to the stock room and again drawn out combined with other assemblies, completing the finished product. Fig. 4 shows the form of stock requisition slip which is given to the stock clerk, who turns to the card or sheet shown in Fig. 5, looking up the corresponding number, which readily locates the article desired. This order after being filled is checked and forwarded to the office where, after being priced, it is filed against the original order. It is not within the range of this article to discuss systems of accounting, but it may be stated that the best results will be obtained where the least time is lost between filling the order and sending it to the accounting department.

In handling steel bars of all shapes iron pipe may be used in the building structure, and the divisions marked with tin tags.

The stock card, Fig. 6, gives a record of the in-coming and out-going material; and the stock clerk after making deduction, should see that the amount in stock is above the low mark which is indicated in the upper right-hand corner. As soon as filled these tickets should be forwarded and old cards filed numerically per part number; but, this work should be done by the stock-keeper and not by his clerks. In every case where the ticket is to be forwarded or parts to be ordered, the ticket should be placed on the stock-keeper's desk where a glance at it will at once convey to him a knowledge of the way things stand in regard to this particular article. Every card should be gone over carefully before forwarding on account of arithmetical errors which are always likely to occur; and, if the stock system is used in connection with the so-called perpetual stock record system, this is imperative as any difference between card and ledger will cause delay in checking for the inventory.

The most important consideration in the organization of a stock department is the selection of stock-keeper who must be a good man even if it be necessary to pay him the highest salary on the roll. This man who has charge of what should be the most valuable department in the plant, should be above

NO. 4250 LOCATION Tai LOW MARK 50

Spindle Arm Assm

IN DATE	IN QUAN.	OUT DATE	OUT QUAN.	ON HAND
6/2	50			50
		6/4	14	36
		"	3	33
6/10	100			133

FRONT

EXAMINED AND FORD 6/2/9 | ORDERED 6/2/9

QUAN. 100 | ORDER NO. 1437

RUSHED 6/8 | ORDER COMP. 6/10

OTHER USES

BACK

Machinery, N.Y.

Fig. 6. Stock Card Recording Stock in the Stock Room

the ordinary employe as regards both ability and character, and one who is indifferent or incapable should not be retained. Furthermore he should have sufficient capability to assume full control of his department. By this it is not to be understood that the stock-keeper is to be allowed to adopt his own methods regardless of the prevailing policy of the management, but that he should be strong enough to fill his position without being constantly called upon to explain errors and accidents, for a man of this type would never be able to manage a department.

* * *

LOSS OF POWER IN GAS ENGINES DUE TO ELEVATION ABOVE SEA LEVEL

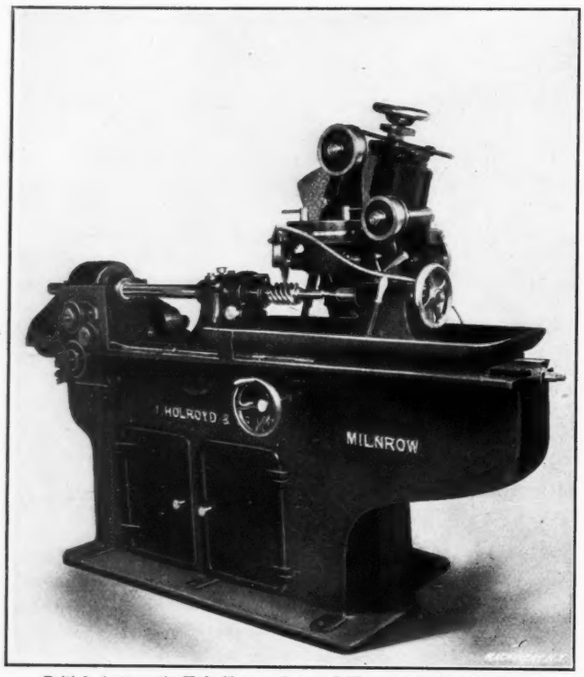
The *Engineering Review* mentions in its November number a case of a large gas engine plant which was some time ago exported from Great Britain to a British colony and erected at the location several thousand feet above sea level. The engines did not give the power expected from them and several reasons were advanced to account for this deficiency. It was finally concluded that the loss of power was due to the altitude of the power station. Upon investigation of the theoretical and practical considerations involved it was found that there is a loss of about one per cent of the indicated horsepower for each 1000 feet increase in elevation. The effect of an increase in elevation on an engine with a low ratio of compression is slightly less than on an engine with a high degree of compression.

BRITISH AUTOMATIC HOB SHARPENING AND WORM GRINDING MACHINE

The illustration shows an interesting British machine designed by J. Holroyd & Co., Milnrow, England, for automatically sharpening all kinds of hobs and for grinding hardened worms. It is also suitable for sharpening cutters within its capacity.

It is a well-known fact that when steel worms are placed in a furnace and casehardened, a certain amount of distortion takes place in the threads which, of course, affects the smooth running of the worm with the worm-wheel. This machine was specially designed to grind the helical surfaces and so insure accurate threads which will run smoothly when in gear. The machine has been taken up by the leading British motor gear manufacturers for grinding the casehardened worms used in the design of motor back axle drives.

The maximum diameter of the worm or hob that can be ground by the machine shown in the illustration is 12 inches and the maximum length, 18 inches. The hobs or worms are carried between centers on suitable mandrels, the maximum distance available between centers being 24 inches. The work is reciprocated past the emery wheel by a screw which is fitted with reversible clutches. These clutches are operated by collars adjustable to vary the length of stroke. A set of



British Automatic Hob Sharpening and Worm Grinding Machine

change-gear wheels is provided to give the required twisting motion to suit the lead of the worm or the helical groove of the hob. The pitch or lead can be varied by the gearing between ½ inch and 250 inches. An important advantage of the machine that will be generally appreciated is that the change gears are the same ratio as those generally provided with universal milling machines; thus the same calculations hold good for cutting the spiral and for grinding it. This means that whatever spiral is cut on the milling machine can be ground on this machine.

Another set of change gears is provided which governs the dividing motion and these come into action when the table is out at its full extent from the driving head, the function of the indexing mechanism then being performed. The emery wheel, which may have a diameter up to 8 inches may be fed down beside hob teeth of an angle up to 30 degrees on either side of the perpendicular. The speed of the emery wheel is 3750 revolutions per minute while that of the countershaft driving it is 375 revolutions per minute. The feed for hob grinding is an extra circular motion put on automatically by means of a weight and lever at the revolutions of the hob. The feed for the worm grinding is a downward motion of the emery wheel, this feed being applied at each revolution of the dividing worm-wheel by a ratchet wheel operated by a pawl on a small worm-wheel which revolves in unison with the dividing wheel. The emery wheel spindle runs in ball bearings provided with adjustment for wear.

The floor space occupied is 9 feet by 3 feet 8 inches, and the approximate net weight 3600 pounds.

* * *

THE PERILS OF AVIATION

To the heavy death toll imposed upon aviators in 1910 were added two fatalities on the last day of the year, John B. Moisant and Archibald Hoxsey, two of the best known and most popular bird men, being dashed to death within a few hours of each other, December 31.

Moisant, who was unknown to the aviation world previous to last August, made himself famous by being the first man to cross the English Channel with a passenger, the machine used being a Bleriot monoplane. What was probably his greatest achievement was his trip to the Statue of Liberty and return, at the Belmont Park meet in October last when, on an unfamiliar machine, his own being out of commission, he won the Ryan prize. Up to the time of his death he had been exhibiting throughout the South. His death at New Orleans was caused by being thrown from his machine when making a sharp dip, his machine being upset by a gust of wind.

Hoxsey has long been in the eyes of the public as probably the most daring of the aviators. He came into prominence at St. Louis by taking Colonel Roosevelt for a short flight. It was he who captured the altitude record by reaching 11,474 feet just six days prior to his death. On the day of his fatal trip he set out with the intention of breaking this record, but apparently things went wrong, for upon coming to the ground in the famous spiral curve, adverse winds were met with. These were fought with success until he was within 500 feet of the ground when he was caught in a bad air disturbance which pitched the machine to the ground.

In the August, 1910, issue of MACHINERY, a list of the aviators that had been killed up to July, 12, 1910, was given. Since that date over twenty deaths have been added to that record, as follows:

August 3. Nicholas Kinet fell 650 feet from his Farman biplane in Belgium.

August 20. Lieut. Marquis Vivaldi killed near Rome in a Farman biplane.

August 27. Van Maasdyk killed by his Sommer biplane turning turtle.

September 23. Georges Chavez died from the result of a short fall from his Bleriot machine at Milan, Italy, after having crossed the Alps.

September 25. Edmond Poillot's machine turned turtle at Chartres, France, while flying with a passenger; the passenger escaped with slight injuries.

September 28. Flockmann died from the result of his machine collapsing at Muhlhausen, Germany.

October 1. Herr Haas killed at Wellen, Germany, by a fall from his machine.

October 7. Capt. Maziewitch fell from a Farman biplane at St. Petersburg, Russia.

October 23. Capt. Madlot killed at Doual, France, by his engine refusing to stop when landing.

October 25. Lieut. Mente killed near Magdeburg, Germany, from a Wright machine.

October 26. Fernando Blanchard at Issy les Moulineux, France, killed while preparing to land.

October 27. Lieut. Sagliette killed at Centosello, Italy, by the aeroplane tipping.

November 17. Ralph Johnstone killed at Denver by the breaking of the left plane.

December 3. Lieut. Cammarata when flying with a passenger in a Farman biplane near Rome, Italy; both were killed.

December 22. Cecil Grace disappeared on a trip across the English Channel from France.

December 25. D. Piccollo, killed in an Antoinette machine at San Paulo, Brazil.

December 28. Alexandre Laffont killed with M. Paulla, both falling from machine.

December 30. Lieut. Caumont killed at Versailles.

December 31. John B. Moisant killed at New Orleans.

December 31. Archibald Hoxsey killed at Los Angeles.

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TIMING AN OFFSET AUTOMOBILE ENGINE*

By M. TERRY†

During the last two or three years the practice of offsetting engines has become very popular with many automobile manufacturers.

The main object in offsetting a motor is to reduce and equalize the wear on the cylinder walls. "Offset" is the distance of the crankshaft center line from the path of the wrist pin center. Theoretical investigations by various authorities seem to point to a rather large offset; in practice, the offset is made considerably smaller, and, in general, its amount is purely arbitrary.

The cylinders are invariably offset in the direction of rotation of the crankshaft. Thus, in the right-handed motor (Fig. 1), the cylinders are offset to the right of the crankshaft.

A case taken from practice and completely worked out will bring forth all the points to be considered by a designer in giving the proper timing to his motor.

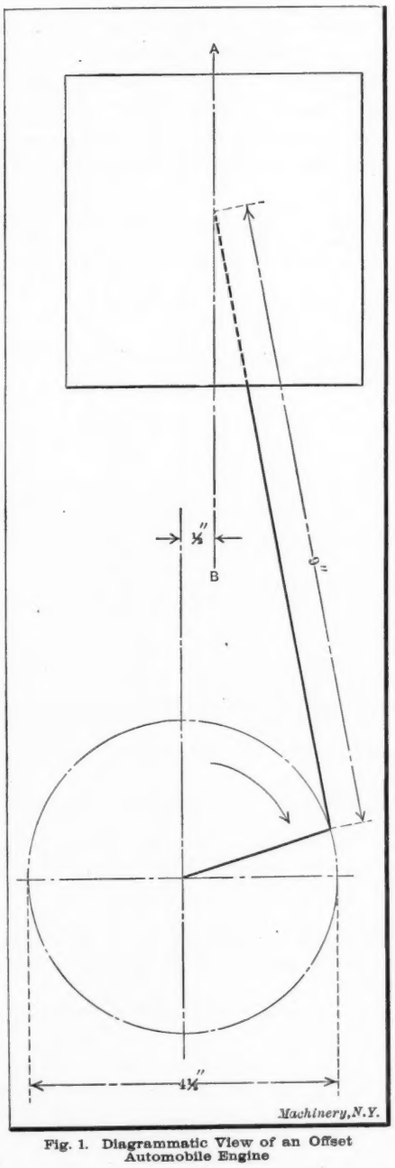

Fig. 1. Diagrammatic View of an Offset Automobile Engine

Specifications

The following are the specifications:

Engine: four-cycle; four-cylinder; right-hand; bore = 4¼ inches; crank throw = 4½ inches; offset = ½ inch; and connecting rod = 9 inches.

Timing:

Exhaust opens 5/16 inch before the lower dead center.

Exhaust closes 1/16 inch after the upper dead center.

Inlet opens 3/32 inch after the upper dead center.

Inlet closes ⅝ inch after the lower dead center.

Valve lift = 9/32 inch.

Base circle of the cam = 1.000 inch.

Diameter of the cam roller = 1.000 inch.

Clearance between valve and valve lifter = 0.005 inch.

While the four timing points are chosen arbitrarily, certain considerations are involved in their selection. On present-day pleasure cars the inlet may close anywhere from ⅜ to ⅞ inch past the lower dead center; *i.e.*, the piston is on its upward compression stroke while the inlet valve is still open. In other words, the inertia of incoming gases is utilized for the purpose of "jamming in" more charge than the suction stroke is capable of drawing in. Since an average automobile engine is capable of running at anywhere from 800 to 1800 revolutions per minute, and the "inlet closes" point (like the rest of the timing points) is fixed on any one motor, the inertia of the gases will

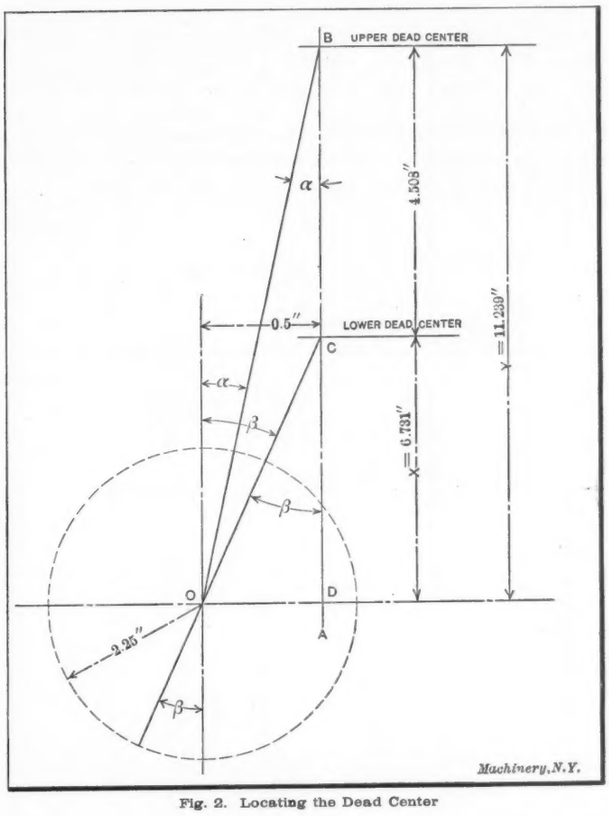

Fig. 2. Locating the Dead Center

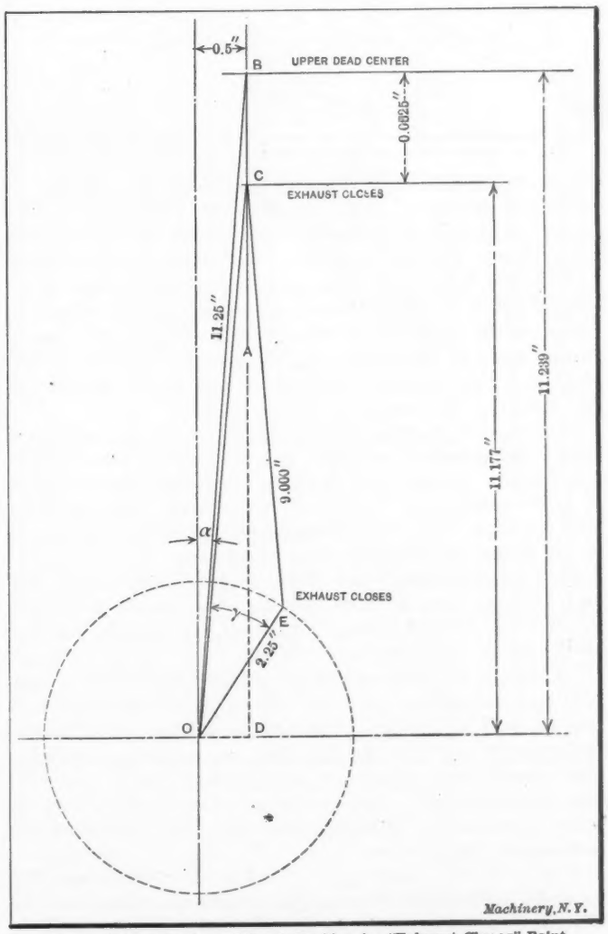

Fig. 3. Determination of Crank Position for "Exhaust Closes" Point

* For additional information on automobile design, see the following articles previously published in MACHINERY: "Offsetting Cylinders in Single-Acting Engines," June, 1909; "Design of Automobile Transmission Gears" (3 articles), October and December, 1910, and January, 1911.

† Address: 302 Williams St., Flint, Mich.

be fully utilized at some particular speed. The maximum volumetric efficiency of the engine occurs at this speed, which may be termed its normal speed.

Engine Classification

The magnitude of this normal speed determines the classification of the motor, *i.e.*, whether it is fast, medium, or slow. The "inlet closes" point is chosen by the designer in accordance with the type of motor he is to build. A slow motor can be forced to run as fast as some high-speed motors, and the latter can be throttled down to the normal speed of some slow

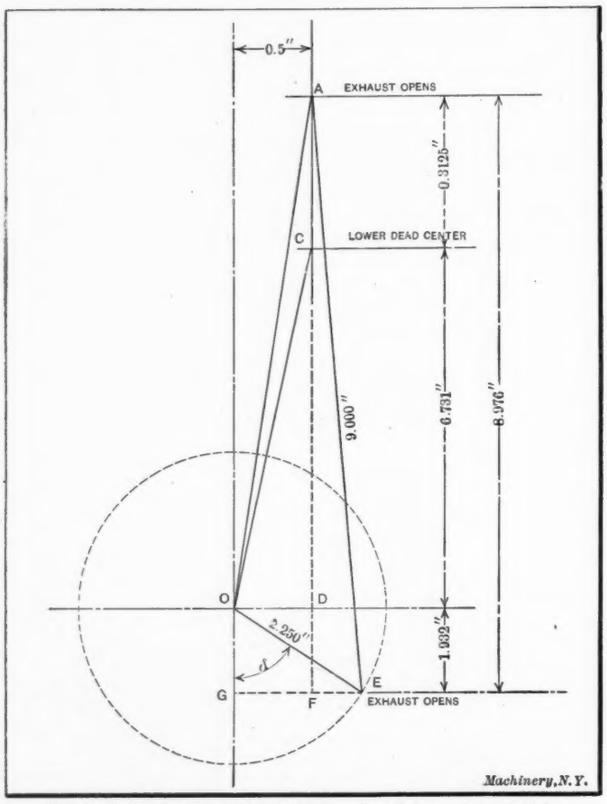

Fig. 4. Determination of Crank Position for "Exhaust Opens" Point

motors, but in either case the end is achieved at a sacrifice of volumetric efficiency. If the speed of the engine is below its normal point, part of the charge taken in will be expelled from the cylinders into the carburetor; and if the speed be above normal, the inlet valve will close before the inertia of incoming gases is fully utilized. In either case it results in falling off of volumetric efficiency. The higher the desired normal speed of the engine, the higher will the "inlet closes" point be above the lower dead center, but within certain limits, of course, its location is a mere guess.

With exhaust opening taking place early in the expansion stroke, the expansion of gases is less complete and waste of fuel greater. On the other hand, early exhaust opening allows of better scavenging. Like the "inlet closes" point it varies with the type of the motor; the faster the engine, the earlier in the stroke the exhaust valve would open.

The "exhaust closes" and "inlet opens" points are, in general, kept the same on both fast and slow motors, and, while the location of each varies with different makers, the two points are placed quite near the upper dead center. For obvious reasons the inlet must begin early in the suction stroke. It is also desirable to keep the exhaust valve open some time past the exhaust stroke, it being another instance of utilization of inertia of moving gases, this time for scavenging purposes. The exhaust valve must also be shut tight before the inlet valve begins to open. Between these three considerations the range of choice for "exhaust closes" and "inlet opens" points is naturally very limited.

A word or two regarding the coming calculations may not be amiss. While the four timing points are practically arbitrary, it is not sufficient to lay out a timing diagram as in Fig. 7, scale off the angles and build the camshaft therefrom, for a slight difference in some angle may cause quite a deviation from desired timing. Also comparison of performances of various motors with different timing is apt to be misleading. It is true that errors in machining and actual construction are bound to occur, but this is no reason why the work in the drafting room should not be accurate.

In order to make their mutual relation clearer, lines, angles, etc., in Figs. 2, 3, 4, 5, and 6 are purposely shown out of scale.

Dead Centers

Consider Fig. 2.

O is the center of the crank circle.

AB is the piston path.

B is the upper dead center.

C is the lower dead center.

OB = length of connecting rod + length of crank = 9 + 2.25 = 11.25 inches.

OC = length of connecting rod — length of crank = 9 — 2.25 = 6.75 inches.

$$Y = DB = \sqrt{OB^2 - OD^2} = \sqrt{11.25^2 - 0.5^2} = 11.239 \text{ inches}$$

$$X = DC = \sqrt{OC^2 - OD^2} = \sqrt{6.75^2 - 0.5^2} = 6.731 \text{ inches}$$

Piston travel = $Y - X$ = 11.239 — 6.731 = 4.508 inches.

To find the angle of offset at the upper dead center

$$\sin \alpha = \frac{0.5}{11.25}$$

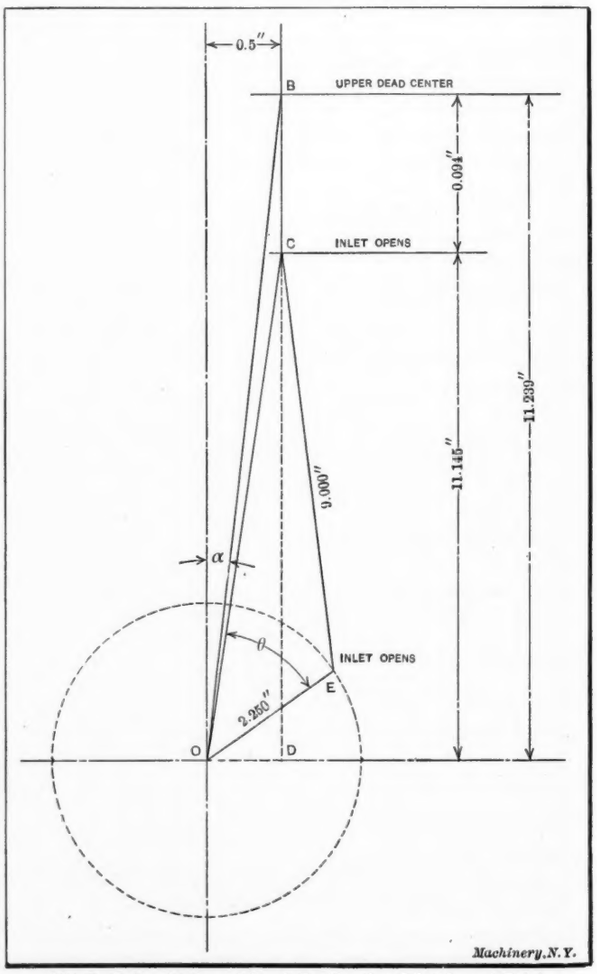

Fig. 5. Determination of Crank Position for "Inlet Opens" Point

Therefore $\alpha = 2° 33'$.

To find the angle of offset at the lower dead center

$$\sin \beta = \frac{0.5}{6.75}$$

Therefore $\beta = 4° 15'$.

Exhaust Closes

The next thing to do is to find the angle formed by the crank with the vertical for the "exhaust closes" point. All the necessary data are given in Fig. 3.

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Angle BOC may be entirely neglected, as from about a dozen different timing diagrams laid out by the writer, with varying offsets, strokes, and lengths of connecting-rods, it has been found that this angle never exceeds three or four seconds, a negligible quantity.

As previously determined,

$$\alpha = 2^\circ\ 33'; \text{ and } DB = 11.239 \text{ inches.}$$

By specification, $BC = 0.0625$ inches.

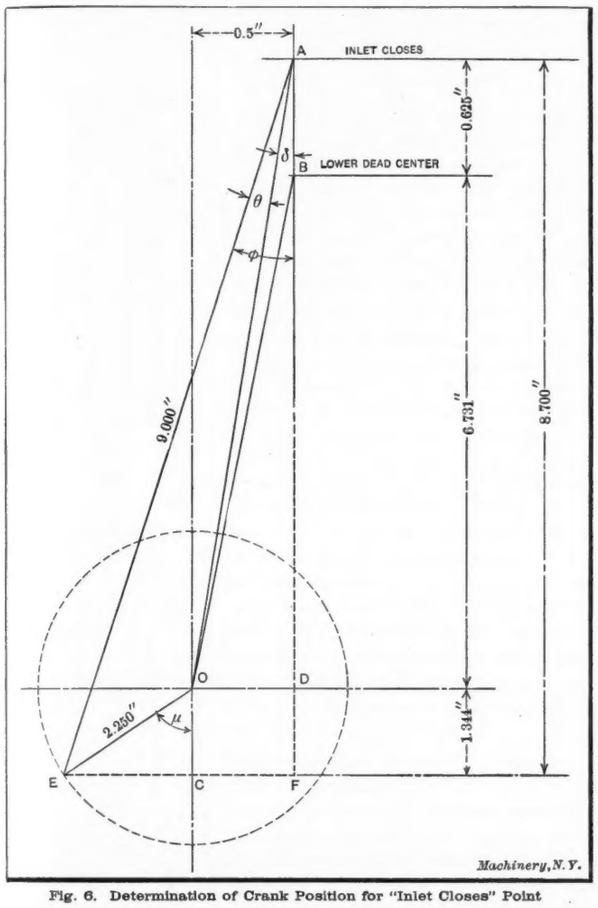

Fig. 6. Determination of Crank Position for "Inlet Closes" Point

Therefore $DC = DB - BC = 11.239 - 0.062 = 11.177$ inches

and

$$OC = \sqrt{DC^2 + OD^2} = \sqrt{11.177^2 + 0.5^2} = 11.188 \text{ inches}$$

and

$$\cos\gamma = \frac{OC^2 + OE^2 - CE^2}{2 \times OC \times OE} = \frac{11.188^2 + 2.25^2 - 9^2}{2 \times 11.188 \times 2.25}$$

Therefore $\gamma = 12^\circ\ 3'$.

and $\gamma + \alpha = 2^\circ\ 33' + 12^\circ\ 3' = 14^\circ\ 36'$, which is the angle made by the crank with the vertical, at the "exhaust closes" point.

Exhaust Opens

Referring to Fig. 4, as before

$OE = 2.25$ inches = length of crank.

$AE = 9.00$ inches = length of connecting rod.

$CD = 6.731$ inches (Fig. 2).

$AC = 0.3125$ inches (by specification.)

Hence

$$AD = CD + AC = 6.731 + 0.313 = 7.044 \text{ inches}$$

and

$$OA = \sqrt{AD^2 + OD^2} = \sqrt{7.044^2 + 0.5^2} = 7.062 \text{ inches}$$

Therefore

$$\cos OAD = \frac{AD}{OA} = \frac{7.044}{7.062}$$

Hence

$$\angle OAD = 4^\circ\ 5'\ 30''$$

also

$$\cos OAE = \frac{OA^2 + AE^2 - OE^2}{2 \times OA \times AE} = \frac{49.868 + 81 - 5.063}{2 \times 7.062 \times 9}$$

Therefore

$$\angle OAE = 8^\circ\ 14'\ 10''$$

Hence

$$\angle FAE = \angle OAE - \angle OAD$$
$$= 8^\circ\ 14'\ 10'' - 4^\circ\ 5'\ 30'' = 4^\circ\ 8'\ 40''$$

Also $FA = AE \cos FAE = 9 \times \cos 4^\circ\ 8'\ 40'' = 8.976$ inches.

and $OG = DF = FA - AD = 8.976 - 7.044 = 1.932$ inches.

Therefore $\cos\delta = \dfrac{OG}{OE} = \dfrac{1.932}{2.250}$

Hence the angle made by the crank with the vertical at the "exhaust closes" point $= \delta = 30^\circ\ 50'$.

By consulting Figs. 3, 4, and 7, it is evident that the total angle described by the crank pin while the exhaust valve remains open, is

$$(\gamma + \alpha) + 180^\circ + \delta = 14^\circ\ 36' + 180^\circ + 30^\circ\ 50'.$$
$$= 225^\circ\ 26'.$$

Inlet Opens

Fig. 5 represents conditions at the "inlet opens" point. As before

$BD = 11.239$ inches (Fig. 2).

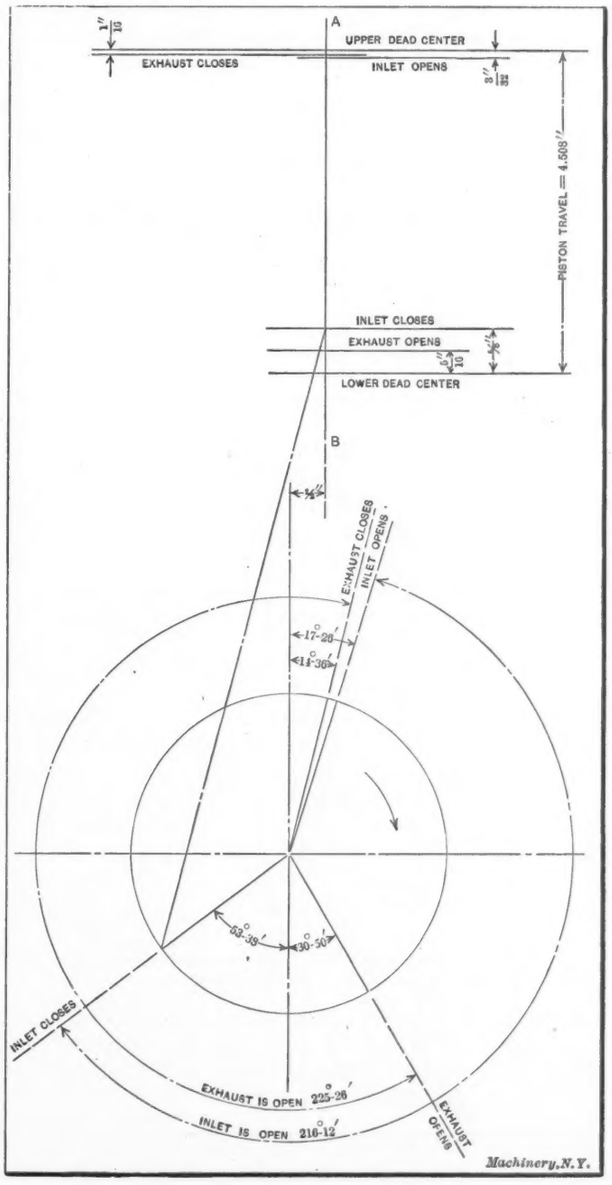

Fig. 7. Timing Diagram correctly laid out

$BC = 0.094$ inches (by specification.)

Therefore $CD = BD - BC = 11.239 - 0.094 = 11.145$ inches.

Hence

$$OC = \sqrt{CD^2 + OD^2} = \sqrt{11.145^2 + 0.5^2}$$
$$= 11.156 \text{ inches}$$

and $$\cos\theta = \frac{11.156^2 + 2.25^2 - 9^2}{2 \times 11.156 \times 2.25}$$

Therefore $\theta = 14^\circ\ 53'$

and $a = 2^\circ\ 33'$ (Fig. 2)

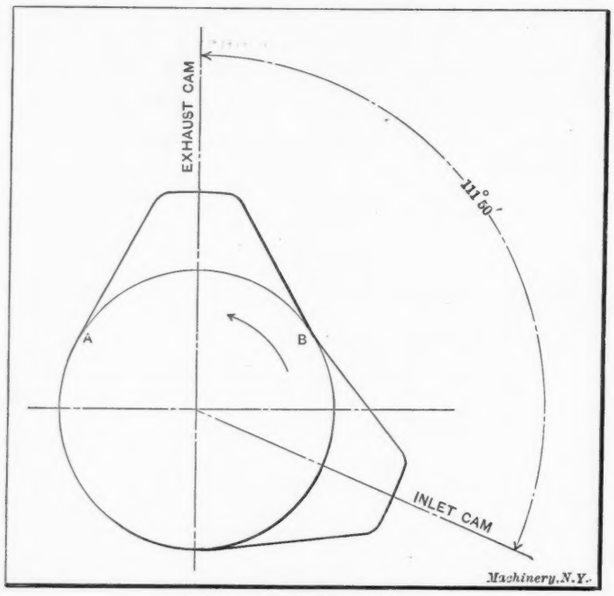

Fig. 8. Completed Set of Cams

This gives the angle made by the crank with the vertical at "inlet opens" position to be

$$a + \theta = 14^\circ\ 53' + 2^\circ\ 33'.$$
$$= 17^\circ\ 26'.$$

Inlet Closes

Conditions for the "inlet closes" point, are shown by Fig. 6. As before

$DB = 6.731$ inches (Fig. 2).

$AB = 0.625$ inches (by specification).

Hence $DA = AB + DB = 7.356$ inches,

and $$OA = \sqrt{AD^2 + OD^2} = \sqrt{7.356^2 + 0.5^2}$$
$$= 7.373 \text{ inches},$$

and $$\cos\theta = \frac{OA^2 + AE^2 - OE^2}{2 \times AE \times OA} = \frac{54.3611 + 81 - 5.0625}{2 \times 9 \times 7.373}$$

Hence $\theta = 10^\circ\ 57'$.

Also $$\cos\delta = \frac{DA}{OA} = \frac{7.356}{7.373}$$

Hence $\delta = 3^\circ\ 53'\ 30''$.

Therefore $\phi = \theta + \delta = 10^\circ\ 57' + 3^\circ\ 53'\ 30''$.
$= 14^\circ\ 50'\ 30''$.

and $AF = AE \cos\phi = 9 \times \cos 14^\circ\ 50'\ 30'' = 8.7$ inches.

Hence $OC = DF = AF - AD = 8.7 - 7.356 = 1.344$ inches.

and $$\cos\mu = \frac{OC}{OE} = \frac{1.344}{2.250}$$

Therefore $\mu = 53^\circ\ 38'$.

By consulting Figs. 5, 6, and 7, it is clear that the total angle described bl the crank pin while the inlet valve remains open, is

$$180^\circ - (a + \theta) + \mu = 180^\circ - 17^\circ\ 26' + 53^\circ\ 38' = 216^\circ\ 12'.$$

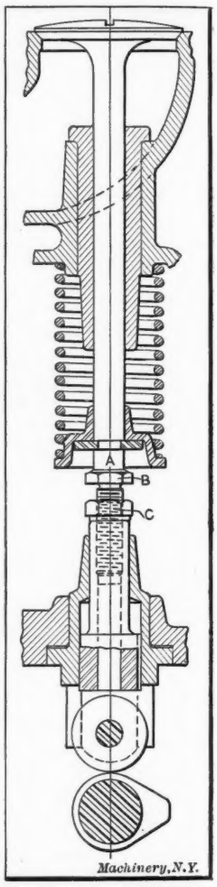

Fig. 12. Valve Mechanism

Half-time Shaft

The term "four-cycle" is a misnomer. A more suitable name for it would be "four-stroke cycle," *i.e.*, a cycle consisting of four strokes of the piston. The four strokes are usually considered in the following order: suction, compression, expansion and exhaust. The action of the inlet cam takes place simultaneously with the suction stroke of the piston. Similarly, the exhaust cam works in unison with the exhaust stroke of the piston. Thus each cam performs its function once in each cycle; in other words, one revolution of the camshaft takes place in each cycle. In the meanwhile the four strokes of the piston produce two revolutions of the crankshaft.

The camshaft, then, makes one complete revolution to two revolutions of the crankshaft; for this reason it is often called the half-time shaft. The two shafts are connected by gears in the ratio of two to one, with the larger of the two gears mounted on the camshaft.

It is clear, then, that while the inlet valve opening, as measured on the crankshaft circle, is equal to 216 degrees and 12 minutes, the inlet cam angle will be half of that, or 108 degrees 6 minutes. Similarly, the exhaust cam angle is equal to 112 degrees 43 minutes. These values are slightly modified by clearance as explained below.

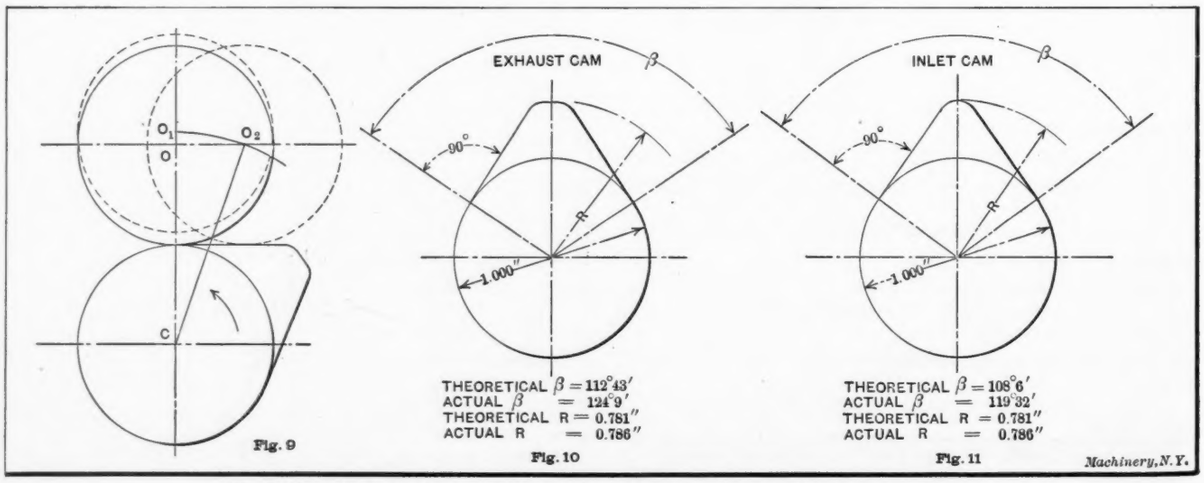

Fig. 9 Fig. 10 Fig. 11

Fig. 9. Determination of Clearance Angle. Figs. 10 and 11. Exhaust and Inlet Cams with Data

Clearance

A very common arrangement of valve mechanism is shown in Fig. 12. Any desired amount of clearance can be provided for by inserting a test gage between the lower end of the valve stem *A* and the head of the bolt *B*, adjusting the bolt and securing it in place by means of the lock nut *C*. It is needless to say that the valve stem end and the bolt head are both car-

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bonized, hardened and ground to a mirror finish, and that so small a clearance as 0.005 inch is by no means a conjecture or a guess, but a definitely known quantity, as near as human skill can make it. The main object of clearance is to permit the valve to seat itself. If no clearance were provided, it would be only a matter of short time before the valve seat will wear out enough to make the base circle of the cam bear the spring pressure during the time the valve remains at rest, and this is accompanied, of course, by leakage of gases. In due course of time the seats wear out from constant pounding

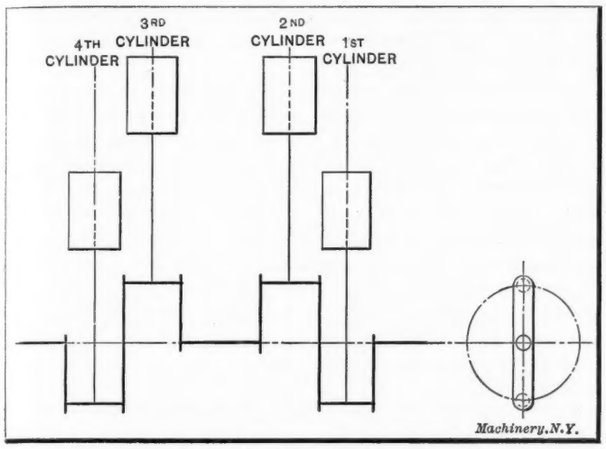


Fig. 13. Crankshaft Construction

of the valves, when they must be ground and new adjustment made.

It will be seen, then, that clearance produces a certain amount of lost motion, which results in shorter time-opening of the valves. To compensate for this lost motion of valves, a certain angle is added to the cam which is known as "clearance angle." Since the lost motion exists on the upward as well as downward travel of the valve, the theoretical cam angle is increased by twice the clearance angle.

Clearance Angle

In Fig. 9, the cam and its roller are shown in a position where the latter begins to rise. The valve however will remain closed till the roller rises 0.005 inch, *i.e.*, from O to O_1. The angle the cam turns through while the roller rises from O to O_1, is the clearance angle. To find this angle, consider the camshaft at rest, and the motor (crankcase cylinders and all) turning to the right. The roller then will move along the face of the cam and the roller center parallel to it. When the roller center reaches O_2 whose distance from C equals CO_1, the valve will begin to rise. The angle OCO_2 is the clearance angle.

By specification:

$OC = 1.000$ inch.

$O_2C = 1.005$ inch.

Therefore $\cos OCO_2 = \dfrac{OC}{O_2C} = \dfrac{1.000}{1.005}$.

and angle $OCO_2 = 5° 43' =$ clearance angle.

Total angle added to the theoretical cam angle is twice this, or 11 degrees and 26 minutes.

Actual inlet cam angle $= 108° 6' + 11° 26' = 119° 32'$.

Actual exhaust cam angle $= 112° 43' + 11° 26' = 124° 9'$.

Figs. 10 and 11 show the application of these results to the two cams.

Cam Setting

The subject of cam setting may come under two heads: Relative position of inlet and exhaust cams controlling the same cylinder; and relative positions of the various sets of cams operating separate cylinders.

To understand the first more clearly, consider the cycle of operations as taking place in the following order: exhaust, inlet, compression and expansion. It will be noticed that the sequence of operations remains unchanged; the advantage lies in the fact that the inlet immediately follows the exhaust; and, in Fig. 8 the exhaust cam comes first with the inlet cam following, and thus no attention need be paid to compression and expansion strokes.

According to the timing diagram (Fig. 7) the angle between "exhaust opens" and "inlet opens" points is

$$30° 50' + 180° 0' + 17° 26' = 228° 16'$$

on the crank circle; on the camshaft the angle will be half of that, or 114 degrees and 8 minutes.

In the case at hand, the crankshaft and camshaft gears are supposed to be in direct mesh (no idler); and since the first turns clockwise, the latter will turn counterclockwise (Fig. 8) and B which is the "inlet opens" point on the camshaft is 114 degrees and 8 minutes distant from A, the "exhaust opens" point. If the two cams were precisely alike, the angle between their center lines would also be 114 degrees 8 minutes; but, since the exhaust cam is the wider of the two, the angle between their center lines would be less by half the difference of the two cam angles. This hardly needs any proof, as a glance at Fig. 8 will suffice.

Exhaust cam angle $= 124° 9'$

Inlet cam angle $= 119° 32'$

Difference $= 4° 37'$

Half difference $= 2° 18'$ about.

Therefore the angle between cam center lines is

$$114° 8' - 2° 18' = 111° 50'.$$

Order of Firing

An exhaust and an inlet cam operating the same cylinder constitute a set, and there is one set of cams corresponding to each cylinder on the engine. All sets being exactly alike, it is only necessary to determine the relative positions of, say, exhaust cams. This is determined by the order of explosions taking place on the engine, and this latter depends on the crankshaft construction, *i.e.*, the number and location of crank pins.

Fig. 13 shows the commonest and perhaps the best form of crankshaft construction used on four-cylinder motors. Ex-

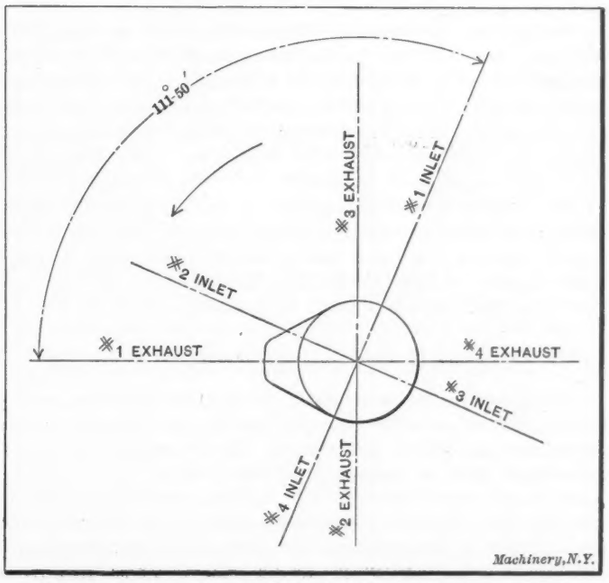


Fig. 14. End View of Camshaft showing Relative Positions of Cams

plosions take place with crank pins on their upper dead centers, and one explosion occurs in each cylinder per cycle. Since there are four strokes in a cycle, and the engine under discussion has four cylinders, there is one explosion for each stroke of the motor.

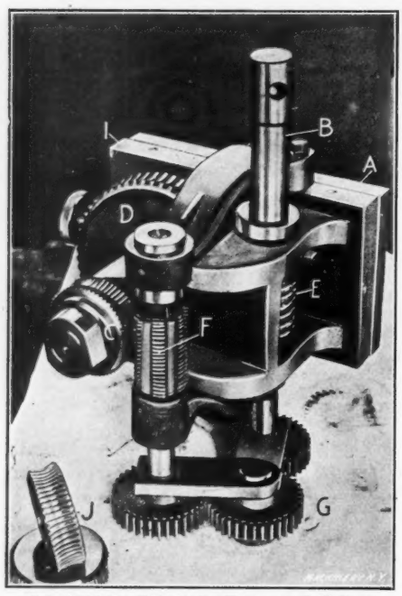
With crank pins arranged as in Fig. 13 there are two possible orders of firing: 1-3-4-2 and 1-2-4-3, numbers 1, 2, 3 and 4 standing for first, second, third and fourth cylinders respectively. The 1-3-4-2 order of firing is preferred by a good many. The explosions are 180 degrees apart on the crank circle, or 90 degrees apart on the camshaft.

Fig. 14 shows the end view of the half-time shaft. With a single exception only, the center lines of the cams are shown. Explanation is unnecessary, as the construction is in agreement with the preceding discussion.

HOBBING SMALL WORM-GEARS ON A DRILL PRESS

By ETHAN VIALL*

A drill press fixture, shown in the accompanying engraving, is used in the shop of the Queen City Shaper Co., Cincinnati, Ohio, for hobbing out bronze worm-gears for lathe aprons, which makes it possible to cut the teeth complete for this particular gear in about one-fourth the time taken by any other method. In using this fixture, the back plate *A*, is bolted to an angle plate which is clamped to the platen of the drill press, the device being placed high enough to enable the lower gears to clear nicely. It may be well to state here that while in use a chip guard covers these gears and protects them from becoming clogged. The mechanism is driven from the drill press spindle through a compensating universal joint coupled to the shaft *B*, which, in turn, drives the gear blank *C*, through the large gear and worm *D* and *E*, and also drives the hob *F* through the spur gearing at *G*.



Gear-hobbing Fixture for Use on a Drill Press

The hob and its arbor are connected to the back plate by brackets, and have no motion except that of revolution, the necessary feeding being done by a handwheel, which operates the cross-slide *I*, upon which are mounted the driving shaft, worm-gear and arbor for holding the blank, the give-and-take in the driving connections between the two parts being automatically adjusted, of course, by the train of gears *G*. Two of the finished worm-gears are shown at *J*, and for the benefit of anyone wishing to make a similar fixture it may be further stated that the worm-gear that drives the work arbor has the same number of teeth as the gear that is cut on the machine and also that the three gears in the train are alike.

* * *

ALUMINUM VS. COPPER CONDUCTORS

It is interesting to compare the relative advantages of copper and aluminum as electrical conductors. The conductivity of aluminum is only 63 per cent of that of copper, but as an aluminum wire of equivalent conductivity of copper weighs only 48 per cent of the copper wire, owing to the small specific gravity of aluminum, it is advantageous for use where weight is a matter of importance. The strength of aluminum wire for equivalent conductivity exceeds that of copper wire by 60 per cent. The cost of aluminum, of course, is higher than that of copper, pound for pound, but it is cheaper for the same conductivity, provided bare wire is used. When the wire is insulated, however, copper has the advantage on smaller sizes, because in wires of the same conductivity the circumference of copper wire would be so much less than the circumference of the aluminum conductor that much less insulating material would be required. This relation, however, holds true only within certain limits, for on larger sizes aluminum again becomes cheaper even with insulation, due to the fact that conductivity depends upon the cross-sectional area, and this latter varies as the square of the diameter and circumference. Hence it will be seen that in comparing the advantages of aluminum and copper for electric conductors, many factors must be considered, and the relative costs, carefully computed.

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FORMULA FOR LOADED RING

Sometime ago the accompanying formula for the stresses in a loaded ring was discovered in an engineer's private note book, and as the same was credited to Mr. Carl G. Barth, the latter was consulted, that something more might be learned about it.

Mr. Barth's reply was in substance as follows: This formula was developed about thirteen years ago when the newer theories of the strength of curved beams were practically unknown in this country, but it is believed that even if applied to this case, the final results would not be greatly modified, except for rings whose mean diameter is small, compared to the diameter of the stock.

This formula is only a special case of a series of general formulas, developed as before mentioned, to determine the stresses and capacity of a ring of any cross-section loaded symmetrically around its circumference with every alternate force tending radially to open the ring, while the intermediate forces act to close it. In these formulas values are first substituted to bring the points of application of the various forces 90 degrees apart, and then make the forces tending to close the ring, zero. The greatest bending moments in the ring then shift to the points of application of the two remaining forces, at which place the direct tension in the ring at the same time becomes zero.

The expression for this maximum bending moment is $\frac{PD}{2\pi}$

where

P = load on ring.

D = mean diameter of ring.

Therefore

$$\frac{PD}{2\pi} = f\frac{I}{y} \quad \text{or} \quad P = f\frac{2\pi I}{Dy}$$

in which I = the moment of inertia of the section,

y = the distance from the center of gravity of the section to the most remote fiber, and

f = the allowable working stress.

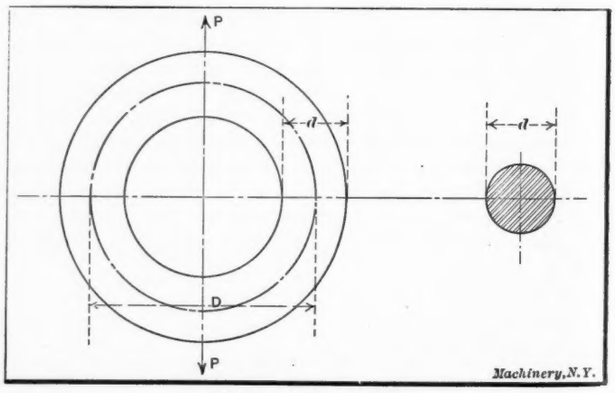


Diagram of Ring Loading

For a circular section of ring $I = \frac{\pi d^4}{64}$ and $y = \frac{d}{2}$

Hence

$$P = f\frac{2\pi\frac{\pi d^4}{64}}{D\frac{d}{2}} = f\frac{\pi^2 d^3}{16D} = 0.617\, f\frac{d^3}{D}$$

which gives the capacity of the ring. From this equation also

$$f = 1.621\, P\frac{D}{d^3}$$

which represents the extent to which the material is stressed for a given load.

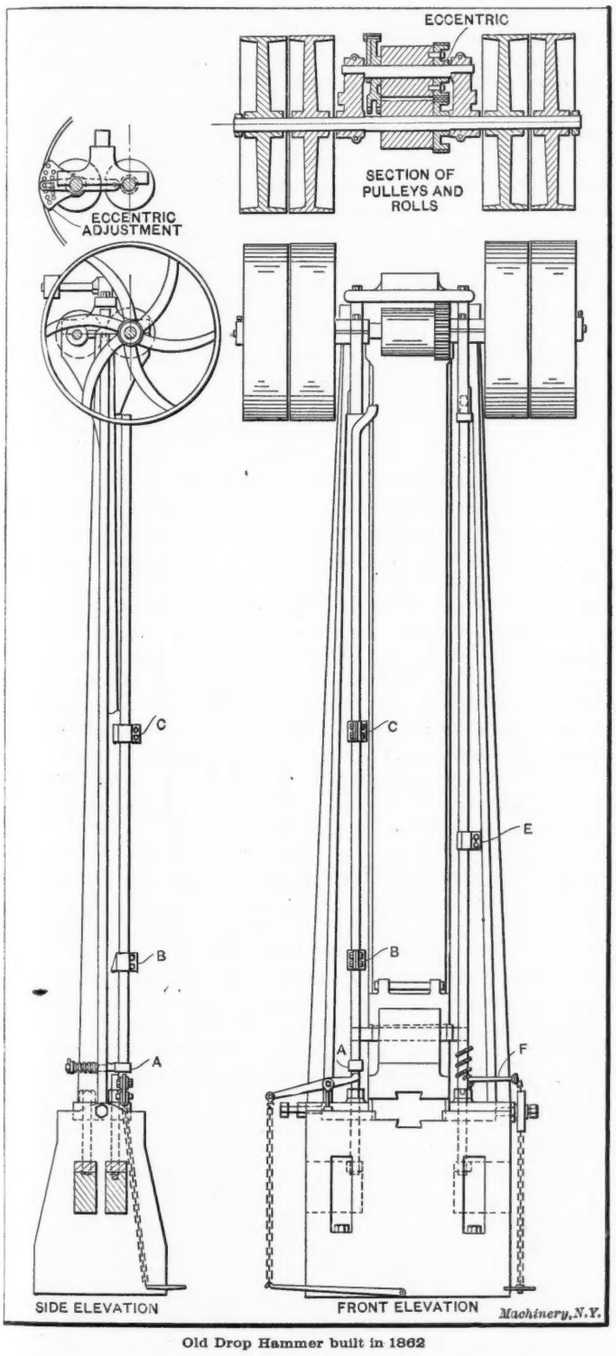
* * *

The Pennsylvania Railroad has now completed or under construction 2000 steel passenger cars. This number includes 600 Pullman parlor and sleeping cars.

A DROP HAMMER OF FIFTY YEARS AGO

By H. TERHUNE*

For upwards of a century power hammers have been playing an important part in the working of metals, among the earliest types being the trip, or what is now known as the helve hammer. The steam hammer was invented in 1842 by James Nasmyth but, so far as is known, the first practical working drop hammer was not designed until 1853, when one



Old Drop Hammer built in 1862

was produced by Elias K. Root, superintendent of Colt's Armory, Hartford, Conn. There is no record of a drop hammer patent until that of Goulding and Cheney in 1861, the principal claim of which was the lifting of the hammer by a belt between two friction rollers revolving in opposite directions.

However, duplicate forgings had been made from dies long before this, the method of so doing being clearly described by C. E. Billings† (founder of the Billings & Spencer Co., Hartford, Conn.) in a paper read before the American Society of Mechanical Engineers, when he was its president. Quoting in part:

"A heavy cast-iron block called the 'sow-block' with a suitable opening in the top for the lower die was held fast by keys and stock to guide the upper die termed 'the jumper.' In the face of the die the forms to be forged were cut as at present, the power being applied by hand hammers and sledges wielded by the smith and his helpers on the upper die with the heated bar of metal held between them. Much time was spent in distributing the stock on the end of the bar of metal before the swaging took place, in order to have the metal flow properly to fill the points of the die."

According to present-day standards this would seem very crude. The accompanying drawing of the drop hammer is dated 1862 and was designed by C. E. Billings. It affords an excellent example of an early type of drop hammer for duplicate forgings. Four of these were built and did good service for years, playing an important part in the manufacture of the old muzzle-loading Springfield rifle used throughout the Civil War.

Like all drop hammers of its time, the hammer was raised by a belt between geared friction rolls, the rear one being driven by tight and loose pulleys, while the front one ran free on an eccentric. With the exception of the adjustment shown in the accompanying drawing, it resembles very much some present-day hammers, especially the front rod and its connections and knock-off dogs.

The lug or finger *A* which formed the lower bearing for the front rod, passed through a hole in the upright with a spring on its end to keep the front rod to its seat at the release of the friction which occurred when the hammer reached the top of its stroke, as will be explained. On this front rod are stops or knock-offs *B* and *C*, the lower one *B*, having a beveled face to correspond to a similar face on the hammer. As the hammer neared the lower end of its stroke, these beveled faces came in contact, the front rod being thereby shoved off its shelf or seat, which action brought the rolls together at the top through the front arm, the eccentric squeezing the belt sufficiently to lift the hammer. At the proper moment the friction was released by a projection on the hammer coming in contact with the upper stop *C*, raising the front rod and releasing the friction from the belt. Several makers of board drop hammers use practically this same knock-off today and while it works satisfactorily, the operation is necessarily very slow, for the front rod will have a tendency to crystallize from the frequency of impact. This is an undesirable feature as speed is quite an important factor, often saving reheating.

The "catch-up" was very crude and would not do for a very heavy hammer. It consisted of another bar extending down the right-hand upright, and having a bearing top and bottom. Secured to it was the catch-up block *E;* to the bottom of this upright rod is a lever *F* from the end of which there is a chain passing over a shaft to a treadle. When ready for the first blow, the treadle was depressed sufficiently to rotate the block *E* from under the hammer. A coil spring on the rod caused it to return to the catch-up position upon the release of the treadle.

The uprights show the tendency of the times towards very high construction, the builders believing that a light hammer and great fall would give the best results, basing their belief on the kinetic energy formula $\text{K.E.} = \frac{Wv^2}{2g}$.

As work becomes heavier and of a somewhat irregular nature, the reverse of the above is considered the best practice. With a heavy hammer and shorter fall, better work may be produced for equal amounts of kinetic energy at the instant of impact. This is accounted for by the fact that under the slower motion the hot metal has better opportunity to flow into the recesses of the dies. It is for this reason that the hydraulic press has such a wide field.

* * *

The boom in aeronautics is in evidence at the United States Patent Office. The applications for patents relating to various machines and methods of control of aeroplanes and dirigible balloons average ninety a month, or about three a day.

* Address: 429 E. 5th St., Plainfield, N. J.

† For further description, see the historical sketch by Mr. C. E. Billings: "A Bit of Drop Forging History," in MACHINERY, May, 1895.

NOTES ON THE ECONOMICS OF LOCOMOTIVE OPERATION*

Every year the demands on the locomotive are more exacting, but contrary to a somewhat common belief, the modern locomotive, if worked to advantage, is an economical machine for what is required of it. The demand for greater hauling capacity has emphasized and enforced the big problem in operation—that of securing at the track the most from every pound of fuel burned. Some lines of progress leading to a greater economy and higher efficiency will be briefly considered in the following:

It is estimated that 125,000,000 tons of coal, or one-fifth of the production of the entire country, were burned last year in the locomotives of the United States. In a recent test conducted at Purdue University, it was found that practically 40 per cent of the heat in the fuel used in a simple locomotive equipped with a superheater, is not utilized in turning water into steam. Possibilities for effecting a considerable saving in coal consumption lie along many lines, among which are the following: By more perfect combustion; better front end construction; compounding; superheating; and by the use of briquetted fuel. To these may be added the saving from the introduction of a perfected mechanical stoker, which will eliminate losses due to improper hand firing.

Approximately 544,000 cubic feet of air are required to supply the oxygen necessary to completely burn one ton of coal, and less air than this means a waste in the form of unburned carbon; furthermore, the air must not only be supplied in the right quantity, but at the right place. The simple principles of combustion may be studied from a common kerosene lamp. The upper part of the lamp chimney corresponds to the stack and the enlarged part is, in the analogy, the combustion chamber, including the front end of the locomotive. The small space just above the wick is the fuel bed, and the air openings below, correspond to the openings through the grates. After the wick is lighted, if turned low, it does not smoke with the hood open, but when the hood is closed, the flame smokes because the air supply has been cut off, which condition is practically the same as when the locomotive has too much fuel on the grate. When the chimney is placed in position, the smoke ceases, and the flame brightens, showing better combustion. This improved condition is due to the fact that the draft draws more fresh air about the wick where it is needed. If a piece of cold iron is held in the flame, the gases are cooled before combustion is complete, which illustrates the condition when too much cold air strikes the flame. After the air supply is shut off by wrapping a cloth about the hood with the chimney in place, the flame smokes, thus illustrating the condition when the dampers in the firebox are closed too much. If a hole is broken in the side of the chimney, or if it is raised from its seat, the flame is chilled and the lamp smokes, and when the fire door of the locomotive is opened, the same thing happens, the gases being chilled before combustion has been completed.

From these simple experiments we learn that the essential conditions for preventing smoke and securing better fuel economy are: 1. That the fuel be supplied in small quantities, and just enough air be passed through the grates to burn it. 2. That the gases be distilled from the coal at a uniform rate. 3. That the air be heated by passing through the bed of hot coals. 4. That the volatile gases given off be mixed with a fresh supply of air, so that each particle of carbon element gets the necessary air supply.

The kind of fuel—its chemical composition, its size, friability, ash, and moisture—also influences economy. It has been demonstrated that briquettes give from 10 to 15 per cent higher evaporation than the run-of-mine coal from which the briquettes were made. Steam can be kept up easier with briquettes, but there is the disadvantage of decreased storage capacity in the tender, difficulty in shoveling, and in firing.

One hundred locomotive tests made for the United States Geological Survey on a number of western roads, showed, in nearly every instance, that the coal, when burned in the form of briquettes, gave a higher evaporative efficiency than when burned in the natural state. For example, Indian territory screenings gave a boiler efficiency of 59 per cent, whereas briquettes made from the same coal gave an efficiency of from 65 to 67 per cent. Decrease in smoke density and in the quantity of cinders and sparks, are given as the chief reasons for this increased efficiency. Other comparative tests show the saving of 20 per cent in pounds consumed per car mile, and with the elimination of black smoke and clinkers. The development lies in the direction of making it possible to use to advantage the low-grade fuels, and in this the briquettes have just begun to open up a new field. The cost of briquetting is approximately $1.25 per long ton.

Another way of effecting economy in operation lies in adapting the train load and speed to the class of engine best suited to the conditions. An example of economy resulting from the use of the Mallet articulated compound locomotive is shown by a test on the Delaware & Hudson Railway: Four runs were made with two pushers of the E 5 class, 2-8-0 type, having a total weight of 246,500 pounds, 217,500 pounds of which is on the drivers. Four runs were also made with the Mallet type, having 445,000 pounds on the drivers. The tonnage of all trains was practically the same and the results showed that the Mallet locomotives did practically the same work as the two E-5 engines, with a saving of 40 per cent in coal and 27 per cent in water.

The superheater, which supplies additional heat to the steam after the latter has been evaporated by the boiler, effects economy in reducing or eliminating cylinder condensation; in increasing the available temperature range of expansion without increase in pressure; and in increasing the steam volume with a comparatively small increase in heat to superheat. The question of the amount of superheat is a most important one. The Purdue tests show that the first 80 to 100 degrees superheat do not give the same proportional decrease in coal consumption as do tne second 80 or 100 degrees. European practice is to superheat until the temperature is from 500 to 600 degrees F., or over; in fact the temperature is made as high as possible without interfering with lubrication, forced lubrication being used for the balanced piston valves.

From tests made on the A. T. & S. F. Ry., the following conclusions were drawn: 1. There is a marked decrease in coal consumption for a superheater engine. The decrease averages 20.8 per cent per thousand ton-miles for up grade runs, 11.5 per cent for down-grade runs, and 19.6 per cent for constant hard working of the engine on heavy grades. 2. A superheater engine uses 10 per cent less water per hour and develops more draw-bar horsepower on heavy work. 3. A superheater engine with 16.6 per cent less heating surface gives an evaporation of 10.6 per cent more water per square foot of heating surface than a non-superheater engine. 4. The superheater engine develops 20 per cent more drawbar horsepower per square foot of heating surface than the non-superheater type.

These tests on the Santa Fé road constitute the most important investigation of superheater equipment for compound locomotives undertaken in this country. Assuming 450 degrees F. as the maximum temperature allowable in the steam chest, the present development, as being worked out, is much more attractive than any of the methods requiring excessively high temperatures.

A theoretical study of the subject shows that a small amount of superheating in the high-pressure cylinder is of little or no advantage; when the pressure drop is large between the cylinders, a material gain is effected by considerable superheat in the low-pressure cylinder; and superheating to 100 degrees or over for the low-pressure cylinder is, theoretically, an attractive proposition.

* * *

A simple method of obtaining the square of a number ending with one-half is as follows: Multiply the whole number of the value to be squared by the next larger whole number, and add ¼ to the product. For example, the square of $2\frac{1}{2} = 2 \times 3 + \frac{1}{4} = 6\frac{1}{4}$, and the square of $10\frac{1}{2} = 10 \times 11 + \frac{1}{4} = 110\frac{1}{4}$.

* Abstract of an article by Prof. Arthur J. Wood, published in the January number of *Stevens Indicator*.

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NOTES ON DRAFTING-ROOM LIGHTING*

Few classes of work call for more active and constant use of the eye than that of the draftsman. The necessity for continual distinction of fine lines and details and the use of finely divided measuring scales and delicate instruments warrants a system of illumination free from all features likely to produce eye fatigue and eye strain, and capable of promoting ease and comfort in such work. The problem is not altogether one of providing light of high intensity. Too much light may be as harmful as insufficient light.

The general requirements for such lighting are:

1—Good and sufficient light for each person.

2—Uniform distribution of light provided by lamps in such numbers and so arranged as to furnish illumination which is satisfactory without regard to the arrangement of tables.

3—An arrangement of lamps that will avoid glare and subsequent eye strain.

4—A system which will furnish illumination on the drawing boards with a minimum of shadow effect when using instruments and ruling devices.

5—An intensity of illumination which will permit the discernment with ease of fine lines and detail, and which will be sufficiently penetrating for tracing work.

Prevalent Methods of Drawing-room Lighting

Numerous methods have been used for the lighting of drafting rooms, some of which possess several of the features outlined above, but they seldom fulfill all requirements. For example, one method of drafting-room illumination is that in which one or two light units provided with reflectors are placed close to the work. This system, casting an intense light on the paper, is not, however, uniform and it is necessary to change the units when the position of desks is shifted, wiring modifications often being called for in such cases. A system of this kind produces a glare from the surface of certain kinds of paper with subsequent eye fatigue. It should be further noted that the resulting shadows are excessive and this requires a continual shifting of the work or lamps and a consequent delay and annoyance.

In an investigation of drafting-room lighting, tests were made in a typical room with bays 16 by 20 feet and a ceiling height of 11 feet 6 inches. A sectional view and floor plan of such a bay, together with the lighting arrangement, is shown in Fig. 1. This typical drafting room contained an average of four tables per bay and could accommodate four persons per bay. The room was originally equipped with large light units spaced on an average of from 8 to 10 feet apart and mounted 10 feet above the floor or about 5 feet 6 inches above the drawing boards. The arrangement is equivalent to about three lamps per bay, or 2.5 watts per square foot. The complaints from the use of this lighting scheme were threefold:

1—The illumination was not uniform, the intensity on some desks being higher than on others.

2—The low mounting height of the lamps, together with the large size of the units required to furnish sufficient light, caused those working in certain positions to suffer from excessive eye strain, both from the glare of the light source and from the reflected light on the papers.

3—Shadows from the small number of light units were dense and required a constant shifting of the ruling devices so as to receive the light on the work at the proper place.

The problem was to provide illumination possessing all the requirements as outlined above, and with features of such excellence as to be satisfactory in all respects for a class of work which rightfully calls for superior lighting facilities. The study of the requirements will show that uniformity, the absence of shadows, and the reduction of glare are the conditions most difficult to obtain. Several methods were given thorough trial before the final scheme was chosen.

Illumination Experiments

The first step was the installation of nine units somewhat smaller than those originally used, arranged as indicated in Fig. 2. Certain draftsmen were set to work in this trial bay. From the beginning the following items were observed: The intensity was excellent, the light uniform, and the glare inappreciable. It soon became apparent, however, that the shadows cast by the large number of units were an objectionable feature. In drawing circles and in the use of the divider generally, some nine shadows standing out in all directions from the instrument and apparently rotating when a circle was described produced confusion and annoyance. This feature naturally gave rise to considerable complaint and led to the suggestion that the shadows might be diminished by the use of more units arranged in groups for a given floor space. As a second experiment, twelve units in four groups were arranged as shown in Fig. 3, the system being made up of four 100-watt and eight 40-watt tungsten lamps per bay. Draftsmen were then placed in this bay so as to work under the light for some days. The same trouble was experienced with shadows in excessive numbers, as was the case in the first trial, the effect being even more noticeable, due to there being twelve lamps per bay instead of nine as before. The lack of uniformity was even more noticeable in this scheme, since each cluster can be considered as one light source as far as independence of desk locations is concerned, and the superiority of nine over four light sources or groups per bay was demonstrated.

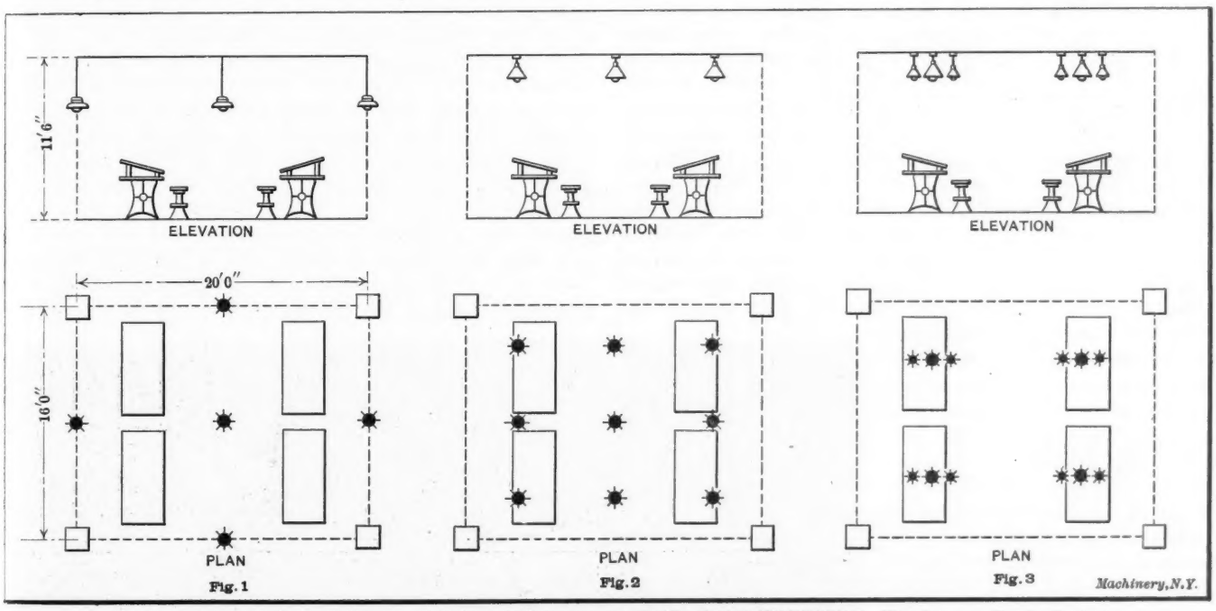

Fig. 1. Typical Bay of a Drafting-room lighted with Large Lamps. Fig. 2. Typical Bay lighted by Nine Lamps. Fig. 3. Typical Bay lighted by Four 100-watt and Eight 40-watt Lamps

* Article published in the *Electric Journal* by C. E. Clewell, lighting expert, with Westinghouse Electric and Mfg. Co., Pittsburg, Pa.

Other arrangements which were given trial were as follows: One bay was finished as an extreme case with 21 units scattered over the ceiling. Here the shadow effect was perhaps somewhat offset by an excessive intensity, but the use of lamps in such numbers would be prohibitive in point of economy, and even if this were not the case it is questionable whether such large numbers would be admissible from the standpoint of good taste.

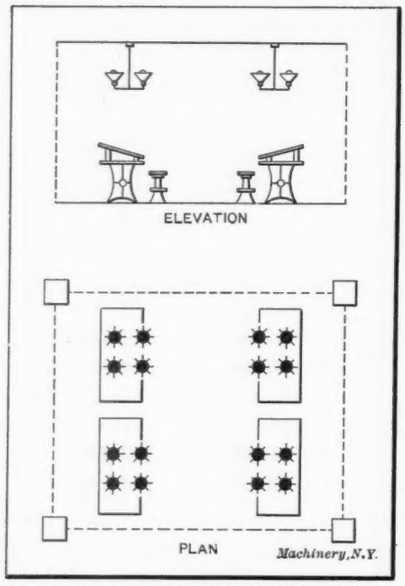

Fig. 4. Arrangement finally adopted Consisting of Sixteen 40-watt Lamps

An arrangement of four 250-watt tungsten lamps per bay, equipped with broadly distributing reflectors, was tried. While possessing some good points, this arrangement made use of units entirely too large for the ceiling height Calculations were made to determine the minimizing of shadow effect in large rooms by the use of broadly distributing reflectors rather than those of a more concentrating type. This involves the building up of intensity at a given point by the light furnished by many distant light sources rather than depending entirely upon the light from one overhead unit. A man leaning over his work will cast a deep shadow, cutting off nearly all of the light if provided by one unit overhead and little or none from distant units; whereas if the units are provided with broadly distributing reflectors, such shadows will be far less noticeable.

The Satisfactory Arrangement

The plan finally adopted consisted of the use of sixteen 40-watt tungsten lamps per bay arranged in clusters of four each, by mounting the units on fixtures so constructed as to make use of the lamps in an inverted position as shown in Fig. 4. The primary thought in this scheme was the attainment of a light free from the shadows found in previous trials. Various types of reflectors and fixtures as well as the effective mounting height of the lamps above the floor were successively tried. With the ceiling freshly painted a yellow tint so as to present a coefficient of reflection of about 0.7, the following items were observed: Opaque reflectors which transmitted all the light coming from ceiling reflection, while providing a shadowless illumination, did not furnish a sufficient intensity for the work in question. The reflectors seemed to give the best results when mounted in a vertical position pointing upward, rather than when mounted in an angular position. Reflectors of a softly diffusing quality of glass and which furnished a considerable amount of transmitted light to the work, seemed to fulfill all the requirements as outlined above. Each draftsman, irrespective of desk or table location, received a good and sufficient light. This light was uniform and was made soft and free from glare by a glass reflector, providing excellent diffusion and a soft yellow tint. The shadows were eliminated and with the use of the correct size of lamp an intensity of proper value was provided throughout the room. This system has been in service long enough to show that, within the limitations of ceiling height and types of units and reflectors available, a very satisfactory result has been obtained.

It is of interest to note that the wattage per bay with this last scheme was practically the same as that found in the original installation. Hence the superior results were obtained by no extravagant installation of larger wattage, but by a carefully arranged plan of the equivalent wattage in another form. The approximate installation expense of the system originally found in use was slightly higher than the new one and the operating expense was sensibly the same as that of the system finally chosen.

It should be stated that the final arrangement of this lighting system was the outcome of experiment rather than predetermination. Much careful study was given to the problem, as it had been anticipated that nine, or at least twelve units per bay, used so as to furnish direct light to the work, would be satisfactory. Draftsmen, without exception, after working for a time under one trial installation after another, favored the final system as furnishing the best illumination of any that had been tried.

Other Influencing Factors

In such a lighting installation as that just described it is likely that different intensities of the artificial light may be needed at different portions of the day and evening. At first thought the usual conclusion is that more artificial light is required at night than on cloudy days. Experience shows the reverse. During the day the eye is subjected to a stimulus from daylight intensities which are ordinarily many times greater than the intensities of artificial light commonly used. In the daytime this causes the pupil of the eye to be in a contracted state so that it requires a greater intensity on the object than is necessary when the eye is relaxed as at night. Thus on a cloudy day, when the daylight is insufficient, a greater intensity of the added artificial light is necessary to produce a satisfactory illumination on the working surface than at night. If the lighting system has been designed for an intensity suitable when used in conjunction with some daylight, it is quite possible that the intensity will be too high for comfort at night. Some way of changing the intensity of the light without destroying its uniform distribution is therefore desirable. If lamps be turned out here and there at random for the purpose of reducing the intensity to the proper value at night, the uniformity of the light is apt to be destroyed.

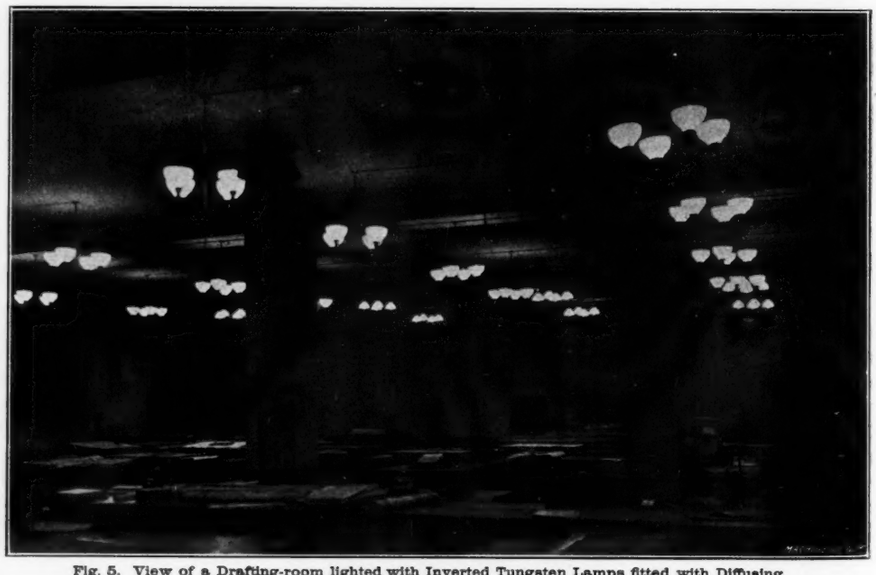
Fig. 5. View of a Drafting-room lighted with Inverted Tungsten Lamps fitted with Diffusing Reflectors—Same Arrangement as that in Fig. 4

One method of varying the intensity, without destroying

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the uniformity of the light, consists in installing the lamps in groups, and turning out a part of the lamps in each group. This affords different intensities without disturbing the uniformity. Often, however, the lamps are not in groups.

The tungsten lamp possesses one feature which can be used to advantage in accomplishing this end, whatever the number and arrangement of lamps. From the normal voltage of the lamp to about fifteen or twenty per cent below normal, the light of the tungsten lamp maintains its characteristic white color. The voltage on such a lighting system may be reduced by means of a transformer arranged with a number of secondary taps to give voltages below normal, thus permitting a change from normal intensity to lower values without noticeably affecting the white quality of the light. This scheme has been used and furnishes a convenient method of varying the light intensity without destroying the uniformity of distribution.

* * *

AN INTERESTING BENDING PUNCH AND DIE

By C. H. ROWE*

The making of the five bends in the piece shown at *D* in Fig. 1, was thought at one time to require a very expensive punch and die. Upon laying it out on the drawing-board, it was found, however, that while there were a large number of parts required and various movements to be provided for, the punch and die would not be at all complicated, and would come within the limit of cost that was allowed for this operation.

The stock from which this piece *D* was to be made was one-quarter hard brass, ½ inch wide and about 0.023 inch thick. The stock was received in strips of the correct width, and previous to bending, it was cut to required length. After the pieces were cut to the required length, holes were drilled and countersunk for wood-screws. As the positions of these holes were not always the same, it was decided to drill them instead of piercing them, while cutting the blanks off.

A front elevation of the punch and die used for completing the bends in the piece shown at *D* in Fig. 1, is shown in Fig. 2. This punch and die was provided with two 1-inch guide-posts for retaining the alignment. These guide posts are not shown in the illustration, but were located at the rear of the moving parts, so as to be out of the way of the operator. In designing this punch and die the usual plan of bringing all the working parts to the front was observed. This facilitates the operating of the die, and obviates the chance of the operator putting his hand in a dangerous position.

Referring to the illustration Fig. 2, *A* is the cast-iron body of the die, which is machined to receive the spring pad *B* and the bending slide *C*. The pad *B*, as shown, is actuated by a coil spring *D*, and is retained in its upward position by the two fillister-head screws *E*. This spring *D* should be weak enough, so that it will be easily compressed by the punch when descending into the die. The slide *C* for making the third bend is advanced by the cam *F*, fastened to the punch-holder as shown, and is retained in its backward position by a coil spring *G*, which bears against a pin G_1, located in the base of the slide.

Referring to the punch-holder, *H* is the punch which gives the first two bends to the blank; the third bend is accomplished by the slide *C* in the die; the fourth bend is made by the punch *I*, and the fifth bend by the punch *J*. The punch *H* slides on two dowels or guide-pins *K*, (one of which is shown) and works against a coil spring *L*. Two fillister-head screws *M*, one of which is shown in the illustration, limit the position of this punch. The forming punch *I* slides on two dowels or guide-posts *N*, and is operated by a coil spring *O*. The downward movement of this punch is limited by two fillister-head screws not shown. The swinging punch *J* rotates on a stud *P*, and is retained by a closed spring *Q*. This punch *J* is fastened by the stud *P* to the block *R*, which, in turn, is held to the punch-holder by two fillister-head screws, as shown.

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In operation, the strip is placed between the locating pins *S* and also between other locating pins not shown, which hold the blank in the correct position. Then as the ram descends, the punch *H* forces the blank down into the die on top of the pad *B*. This forms the blank into the shape as shown at *A* in Fig. 1. On further movement of the ram, the cam *F* comes in contact with the slide *C* forcing it in and bending the blank over the projected part H_1 of the punch *H*. This forms the blank to the shape as shown at *B*, Fig. 1. As the ram descends still further, the punch *I* bends the blank around the punch H_1, giving it the shape shown at *C*, Fig. 1.

The fifth bend is made by the punch *J*, and is accomplished as follows: As the ram still continues in its downward move-

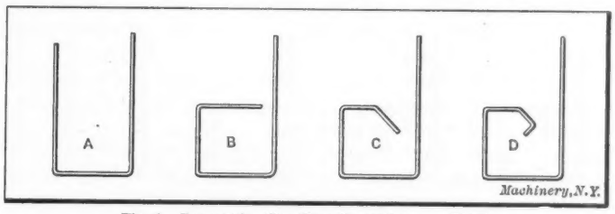

Fig. 1. Successive Bending Operations on Blank

ment, the punch *J* comes in contact with the block *T*, fastened to the die-block as shown. This block *T* rotates the punch *J* on the stud *P*, and forces the blank around the punch H_1. On the up-stroke of the punch-holder all the slides and punches are returned to their normal position, the projection H_1 on the punch *H* carrying the blank out of the die and leaving it in the position shown by the dotted lines, when it is then removed by hand. The forming part of the punch *J* is offset from the main body of the punch as can be seen, so that the blank will slide up past it. The forming part H_1

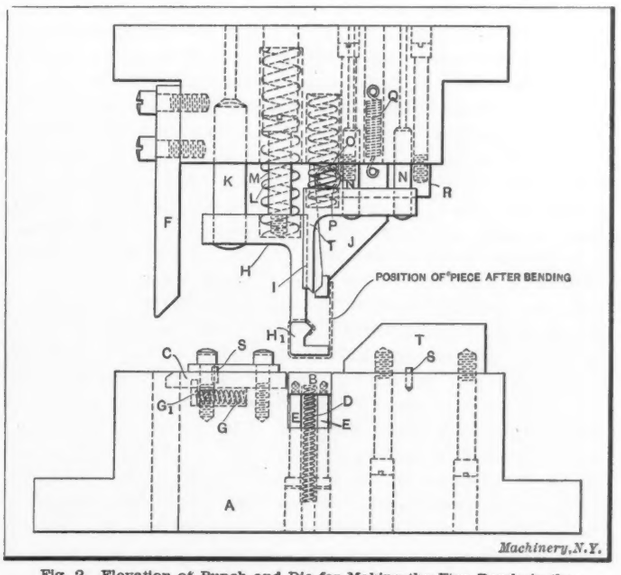

Fig. 2. Elevation of Punch and Die for Making the Five Bends in the Piece shown at D in Fig. 1

of the punch *H* is also offset, thus allowing the blank to be bent around it.

All the springs in a punch and die of this description should be of the best quality and well tempered, so that they will not become fatigued to such an extent as to render any part of the mechanism inefficient to even a slight degree. No trouble, however, was experienced in this regard in the above-mentioned punch and die.

* * *

For nearly seventeen years an oil hole in the quill of an engine lathe back-gear was regularly oiled by its operators. One day a mechanic of a more investigating turn of mind than his predecessors made the discovery that the hole was not quite drilled through. All these years the back-gear, when in use, had run without oil, and no one had been the wiser. There is no particular moral or lesson to be drawn. It is simply one of those cold hard facts that makes one wonder what kind of brains some men have.

CARE AND MAINTENANCE OF MACHINE TOOLS IN A LARGE PLANT*

The American Locomotive Co. in its various plants have about 9000 machines. It is evident that the maintenance of this equipment requires a considerable organization, if the equipment is to constantly be up to its highest standard of efficiency. A few years ago such an organization was formed for the purpose of increasing the production of the plant with the least possible cost of the maintenance of the machinery. At that time a great number of machines of obsolete and complicated design, were in use in the plant, operated, for the most part, by inexperienced workmen. The growing use of high-speed steel in machines not especially designed for the heavy strains thus imposed, also made the cost of maintenance of these machines very high.

The first step taken was to create an organization dividing the work of maintenance into different departments. In charge of the whole organization is placed the mechanical superintendent, and under him a general engineer of maintenance who, in turn, at each plant has a local engineer of maintenance whose duty it is to look after all equipment such as machinery, buildings, grounds, tracks and rolling stock. The power plant is looked after in a similar manner, there being a general engineer of power with a local engineer of power at each plant, his duties being to look after such matters as power production, purchase and distribution of power, heat, light and water, fire protection, watchmen, etc. In addition there is a general small-tool supervisor with a local supervisor at each plant, whose duties are to look after all matters pertaining to the local tool-room, such as taps, reamers, twist drills, milling cutters, tool steel, and the like.

In addition to the officials mentioned there is at each plant an inspector of equipment, whose duties are to investigate and report on all conditions which might tend to cause failures in the operations of machines; he also investigates and reports on all conditions which might cause accidents to employes, on abuses of equipment by the operators, and on equipment which is not kept clean and in order by the operators. The equipment covered by these reports includes machine tools, power equipment, pipes, sewers, buildings and structures, rolling stock, cranes, elevators, etc. By means of this organization it is possible to keep constantly in touch with the conditions of the equipment in all the various plants.

A small printed form is used on which every machine tool failure is reported, showing the time when the machine failed, the cause of the failure and the estimated cost of repair. When the repair has been completed, the actual cost of repair and the length of time the machine has been out of service due to the failure are also reported. These reports are kept for each individual machine, so that there is a perpetual record of the performance of every machine in the plant. The failures are also classified under four heads, as: failures due to negligence, to improper design, to accident, and to ordinary wear. Each of these failures is systematically investigated. Those due to negligence are taken up with the men in charge of the operators with a view to having the machines better cared for. The failures due to accident are investigated, and, if possible, steps taken to reduce the number to the minimum. When failures are due to improper design, the weak parts are redesigned and strengthened. As regards the failures due to ordinary wear, investigations are continually being made to see if it is not possible to simplify the construction of the machines and reduce the number of parts required to the minimum.

The system outlined was installed in 1907. The results obtained have been very satisfactory. The cost of maintenance has constantly decreased since the installation of the system. The present cost of maintenance is about one-third of the cost at the time when this system was instituted. The saving effected in all the plants of the American Locomotive Co. amounts to thousands of dollars a month. At the same time, the number of productive machine-hours that are lost due to failures has been reduced from 12 per cent to 1.75 per cent. To illustrate just what this means, it may be well to mention that out of the 9000 machines in all the plants, about 1000 were out of service all the time on account of repairs when this system was begun, while at the present time this figure stands at an average of 100 machines only. It is interesting to note how these results were effected in one of the shops. By referring to the reports it was found that about 40 per cent of the failures were due to negligence. It has since been possible to reduce this negligence factor to 1.25 per cent.

In another case it was found that a certain type of machine tool was purchased having an error in its design which had existed for ten years on this make of machine and which was costing the American Locomotive Co. something like $5000 a year. This matter was taken up with the machine tool builder and the design changed, eliminating this entire charge of repairs. It was found that the maintenance of some types of machines was so heavy that it was concluded a waste to keep them in service, and they were replaced with modern tools.

The system has also made it possible to determine definitely what is the most economical design of the machines used, from the user's standpoint. Most of the machine tools now purchased by the company are built to specifications prepared by its own engineers, and the aim is to cut out every gear and moving part not actually needed for the work. Planers, for example, are made with only one speed, because the works are so extensive that one planer can be put on one class of work and never changed. On vertical milling machines but one pair of gears is used between the motor and cutting tool, and on large vertical boring mills the gear boxes have been cut out and the drive is equipped with a big plain pulley, the power being obtained from a variable speed motor placed in the ceiling where the countershaft was formerly located. On radial drills the speed of the driving shafts has been lowered and the diameter of the shafts increased, so as to reduce the cost of maintenance of the bearings.

The question of the economic use of power in operating machine tools has been investigated in this connection. In testing out some of the machines it was found that there was a considerable amount of power absorbed through the friction of unnecessary gears. This is one of the reasons why an attempt has been made to cut out every gear possible on all new machines purchased. The result of this policy is that on a new design of radial drill where all except one pair of gears are done away with, the frictional load of the machine when running idle at the rate of about 160 revolutions per minute is only 0.7 H.P., while the same machine running at approximately the same speed drilling a 1¼ inch hole with a cutting speed of 50 feet per minute and a feed of 0.022 inch will use 5 H.P. In another case, a machine running at about 335 revolutions per minute will use 1 H.P. when running idle, while it requires 8 H.P. when drilling a 1-inch hole at a cutting speed of 85 feet per minute and a feed of 0.022 inch. Hence the percentage of power used for the machine when running idle is small.

* * *

The development of flashing electric signs in the last ten years has been remarkable. In New York City, thousands of dollars are invested in electric signs which in some cases are engineering structures of great magnitude. The ingenuity displayed in securing motion effect, both attractive and lifelike, is also remarkable. Galloping steeds hitched to Roman chariots rush madly on, the effect of flying limbs being simulated by rapidly lighting and extinguishing successive rows of lamps representing the horses' legs. One of the best illusions is produced by an electric sign overlooking the North River. This represents an enormous beer bottle emptying into a glass. The liquid apparently flows and fills the glass, and the empty space in the bottle grows before the eyes. The stream twinkles, the foam rises in the glass and the lower part clears so naturally that thirsty ones on their way home to Jersey o' nights sigh appreciatively.

* Abstract of a paper read by Mr. C. K. Lassiter before the National Machine Tool Builders' Association Convention, in New York City, October 26, 1910.

FEB 2 1911

THE PROBLEM OF CONE FRICTION CLUTCH DESIGN*

By OSKAR KYLIN†

Oskar Kylin‡

The following article has been prompted by a certain meagerness of information in the engineering handbooks and other technical literature regarding the various coefficients and constants that are to be used in the calculations of cone friction clutches for different purposes, and also by the desire to induce cone clutch specialists to give their views of the problem that confronts the designer, and thus promote a more thorough understanding of the factors of vital importance in the designing of this important machine part.

In Fig. 1, *A* represents a cone clutch which constitutes a part of the reversing mechanism of a motor-driven machine tool, more particularly a turret lathe. The clutch *B* is a part of the speed changing device. The shaft *C*, carrying the two small gears for the direct and reverse drive, is directly connected to the constant-speed motor, and, hence, runs at a high speed. Referring to Fig. 3, the common way of calculating a cone clutch of this kind is as follows: By previous calculation it has been found that the turning moment to be transmitted through the clutch at full load is M. Let:

D = mean diameter of clutch,
B = width of clutch,
α = clutch angle,
P_n = normal pressure between friction surfaces,
P_s = unit (specific) pressure on friction surfaces,
P_a = axial force on clutch,
μ = coefficient of friction.

Then

$$P_n = M \times \frac{1}{\frac{1}{2}D} \times \frac{1}{\mu} \qquad (1)$$

$$P_a = P_n \sin \alpha + \mu P_n \cos \alpha \text{ (engagement without slip)} \qquad (2)$$

The term $\mu P_n \cos \alpha$ is an expression for the force necessary to overcome the friction between the two clutch surfaces just at the moment of engagement. The method of arriving at Formula (2) was given in MACHINERY, October, 1909, engineering edition, and need not be gone into at this time.

$$P_s = \frac{P_n}{\frac{1}{2} B D \pi} \text{ (approximately)} \qquad (3)$$

The difficulty that confronts the designer at this stage of the problem consists in choosing the right value for the unit pressure P_s, for the material or case in hand, and it is here that engineering handbooks fail to give the required information. Some of the important factors that influence the value of P_s are: where and how the clutch is applied; whether reversing or not; the speed of the friction surfaces; and the inertia of the revolving or moving parts to be reversed or started by the clutch. Fig. 2 tends to give an idea of how these factors have to be taken into consideration. The clutch at *A* is a reversing clutch and runs at high speed, and has the mass of the following gear train, the chuck, and the work, to reverse, which means a great strain on the friction surfaces; therefore, a lower value for P_s has to be chosen for this clutch than for *B*, *C* and *D*, which clutches have slower surface speeds and smaller masses of machine parts behind them to start, and which do not reverse. However, a lower value of P_s must be chosen for *B* than for *D*.

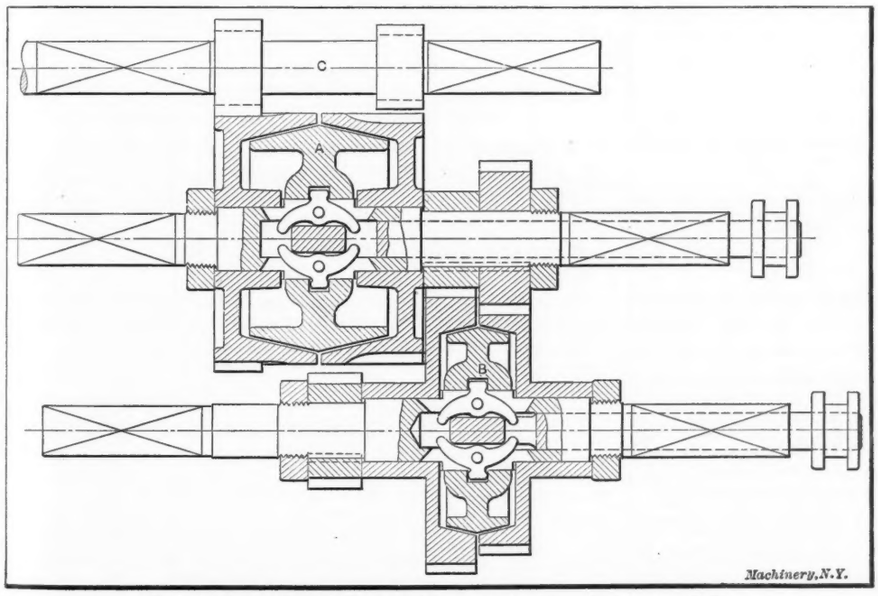

Fig. 1. Design of Geared Turret Lathe Head, with Reversing Friction Clutch

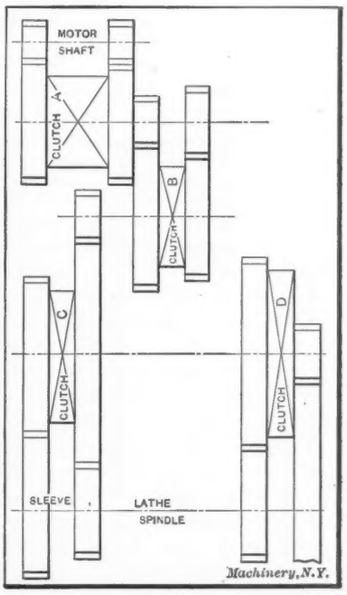

Fig. 2. Diagrammatic View of Friction Clutch

If P_s is chosen much smaller than necessary, the clutch will be disproportionately large, and consequently too expensive to manufacture, and if chosen too large, the friction surfaces will get overheated at the moment of reversal, or starting, and wear out too fast.

Considering the case illustrated by the clutch *B*, Fig. 1, this is not, as already mentioned, a reversing clutch, and its most severe strain consists of picking up the load from rest. According to the A. S. M. E. *Journal*, a 24-inch clutch of the Falls Rivet & Machine Co.'s make will probably break at 100 R. P. M. when transmitting a load of 200 H.P. or when picking up a load exceeding 110 H.P. Wooden blocks on cast iron are used in this clutch, and whether these data apply to the metal-to-metal friction clutch under consideration is doubtful. However, it goes to prove that the strain produced by the picking up of a load is far in excess of that produced by the mere transmitting of the same load.

* See MACHINERY, October, 1909, engineering edition: "Formulas for Cone Clutches." See also MACHINERY'S Data Sheet Book No. 8, page 24, "Formulas for Cone Clutches."

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‡ Oskar Kylin was born in Ornunga, Sweden, in 1882. After having graduated from the Department of Mechanical Engineering, at the Technical College of Boras, Sweden, he was employed as draftsman and designer by the locomotive works of Nydqvist & Holm, Trollhattan, and the ordnance works of the Bofors-Gullspang Co., both in Sweden. In the spring of 1905 he came to the United States, where he has been employed by the Pratt & Whitney Co., Hartford, Conn., the American Diesel Engine Co., of New York, the Taylor Iron & Steel Co., High Bridge, N. J., and the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio. His specialties are the designing of gas engines and machine tools. In the Spring and Summer, 1908, Mr. Kylin traveled extensively in several European countries to study machine building practice, during which time he acted as an editorial representative of MACHINERY.

In the case illustrated by clutch *A*, Fig. 1, the most severe strain is caused by reversing. At the moment of reversal, slipping between the male and female friction surfaces must be allowed as an instantaneous reversal would create an excessive strain on all parts of the mechanism, and is practically impossible. The less the slippage, the quicker will the reversal be, and the larger the clutch which must be employed; or, in other words, the size of the clutch is inversely proportional to the time allowed for the reversal and to the slippage. As slippage must occur, the clutch has, in the opinion of the writer, several features in common with the journal and bearing. Lubricant applied to the friction surfaces would probably be desirable to prevent cutting while the slipping takes place, but this is in most cases impracticable. The

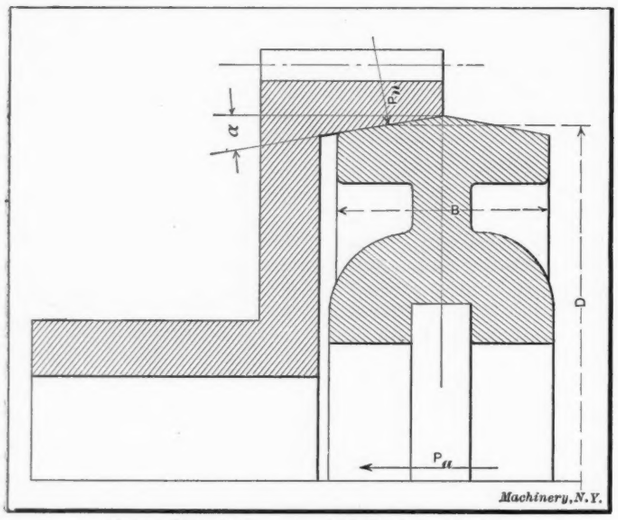


Fig. 3. General Arrangement of Clutches and Gears

value of the unit surface pressure stands in a more or less close relationship to that employed in journals, but the time factor of slippage, the lubrication, etc., must also be considered.

In order to arrive at a better understanding of how the various factors influence the unit pressure, we will calculate the clutch *A*, Fig. 1. A 10 H.P. motor at 1300 R. P. M. will, with the gearing shown, friction losses not being considered, produce a turning moment in the shaft of clutch *A* of 1460 inch-pounds. This must be transmitted through the friction clutch. The coefficient of friction in this case, for phosphor-bronze on cast iron, can be assumed as 0.15, which probably is a fair value. The angle a should be large enough so that the clutch does not "stick" when the end pressure is released, or, in other words, tan a must be larger than μ. In the clutch under consideration a is equal to 12 degrees, a value frequently employed.

The diameter is in this case predetermined by the size of the adjoining gears, a situation that often confronts the designer. The mean diameter is here 7½ inches. The dimension to be determined by the calculations is the width of the clutch face, or *B*.

Referring to Equation (1) we have: $P_n = 1460 \times \frac{1}{3.75 \times 0.15}$

$= 2575$ pounds.

Assuming, further, the unit pressure P_s to be 150 pounds per square inch, the width will be, from Equation (3):

$$B = 2 \times \frac{2575}{150 \times 7.5\,\pi} = 1.45 \text{ or, say, } 1\tfrac{1}{2} \text{ inch.}$$

The normal pressure of 2575 pounds is, of course, enough only to transmit 1460 inch-pounds as a constant load, and would not be enough to pick up this load without an excessive amount of slippage. To prevent this excessive slippage, a normal pressure of upward of two or three times 2575 pounds might be required. This extra pressure can, however, easily be taken care of by means of the adjusting device, and, if a proper value is allowed for P_s, it does not need to enter directly into the calculations of the friction surface, but it has, of course, to be considered in connection with the shifting or locking mechanism.

Regarding the value of P_s used—150 pounds—the writer considers this a safe value for the clutch *B* for cast iron on cast iron, with a friction surface speed of not more than 550 feet per minute, but it is too high for clutch *A*. In fact, a clutch corresponding to that shown at *D*, Fig. 3, and carrying its highest load at a surface speed not exceeding 350 feet per minute is calculated with a value of P_s equalling approximately 185 pounds for cast iron on cast iron, and this clutch has given entire satisfaction during years of service. A higher surface speed requires a lower value of P_s.

For a reversing clutch, the unit pressure should probably be about half of that for a non-reversing clutch. The writer has no experience to back up this assumption, which is based merely upon pure reasoning. Clutch *A* runs at about twice as high a surface speed as *B*, but is cast iron on bronze, and it is very probable that a unit pressure of 60 pounds per square inch is a safe value. Using this, we get:

$$B = \frac{2 \times 2575}{60 \times 7.5\,\pi} = 3.64 \text{ or, say, } 3\tfrac{5}{8} \text{ inches.}$$

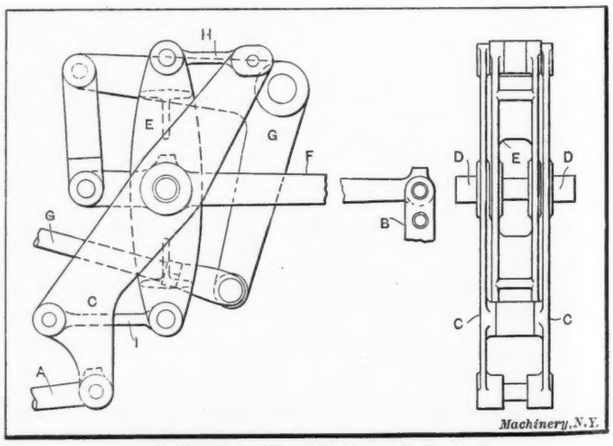
This example is quoted only to demonstrate how the size of a clutch is influenced by the variations of the value of the normal unit pressure on the friction surfaces, and this, in turn, by a load factor that depends on where and how the clutch is used, the surface speed of same, etc. The purpose of this article is only to prompt a discussion of the subject, in order to bring out some valuable data of the nature which the writer has indicated the need of.

* * *

LOCOMOTIVE VALVE GEAR

A modification of the Walschaerts valve gear is described in U. S. patent No. 976,542 (November 22, 1910), by James G. Blunt, Schenectady, N. Y. In general principle these gears are very similar, the principal feature of this one being the absence of a sliding contact, nothing but pin connections being required.

A is the eccentric rod connected to the main driver and *B* the combination lever connected to the crosshead, both as in



A Modification of the Walschaerts Valve Gear

the Walschaerts gear. Double levers *C* are trunnioned at *D* on stationary bearings. Lever *E* is pinned at its center on the radius rod *F*, the latter being suspended from the bell-crank, controlled from the cab by the reach-rod *G*. Levers *C* and *E* are connected by short arms *H* and *I*, the latter being slightly longer to effect a substantially radial motion when the radius bar *F* is moved to change the direction of movement or point of cut-off. These latter operations are performed by raising or lowering radius bar *F* by means of bell-crank *G*. This sets *H* and *I* at an angle, which, when increased, produces a decreased travel of the lever *E*, causing a similar decreased valve travel, and thereby an earlier cut-off.

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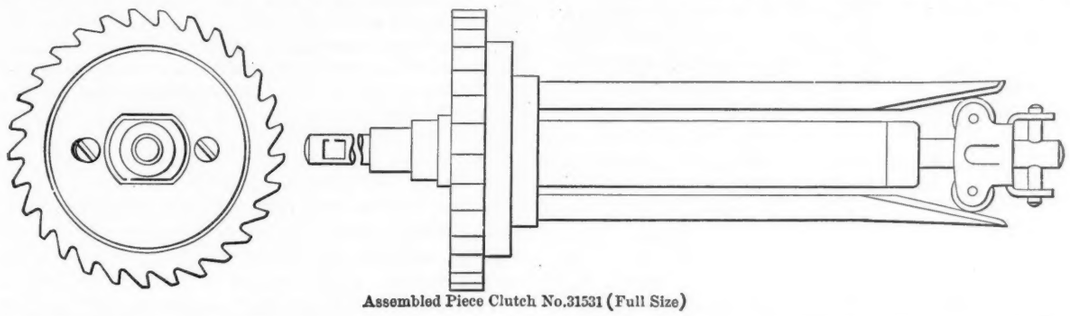
A SYSTEM FOR ASSEMBLING SMALL INTERCHANGEABLE PARTS*

The direct labor cost of assembling small interchangeable parts is a comparatively large item in light mechanical engineering and repetition work. Economical production demands that easy assembly be kept in view at all stages, from the designing of a mechanism, through the tooling and shop processes, to the delivery of the unit parts to the assembler. The shop shall, from the first, begin the assembling of the mechanism under the most economical conditions.

An efficient assembling system requires that the parts be assembled at the highest possible speed and that the assembled mechanism embody the prescribed quality of work, neither more nor less. These conditions are fulfilled with the best economy when the classes of labor available are properly selected, graded and trained for the various operations.

In many industries the methods used in assembling are ar-



Assembled Piece Clutch No.31531 (Full Size)

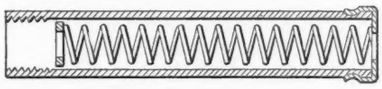
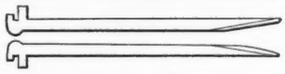
Stage No.	Unit Parts 18 in Number Assembled in 10 Stages	Operations in Sequence	Grade of Labor	Average Time Including Stops, from Records of 100,000 Pieces	
				Min.	Sec.
1		Ream 2 holes 0.073″ in Roll Holder No.30670 on speed lathe	Women	0	7
2		Assemble roll holder No.30670 2 rolls No.30680 and 2 pins No.67640 at bench	Boys	0	45
3		Ream 1 hole 0.166″ in clutch frame No.30361 on speed lathe	Women	0	5
4		Tap 2 holes 0.08″-56 in clutch frame No.30361 on tapping machine	Men	0	16
5		Ream 2 holes 0.085″ and 0.059″ in shaft No.31620 on speed lathe	Women	0	10
6		Straighten shaft No.31620 on bench block	Boys	0	8
7		Put pin No.65610 in shaft No.31620 with bench fixture	Boys	0	20
8		Put in washer No.90000 and assemble tube No.31521 and spring No.67210 at bench	Men	2	24
9		Bend and gage clutch jaws No.30690 in bench vise	Men	0	31
10	See full-size sketch	Assemble clutch jaw No.30690 ratchet No.30370, frame cover No.30330, 2 screws No.70402, and roll holder comp., with pins No.64650 at bench	Men	3	52
	The direct labor cost of assembling 1 clutch No.31531 is 3.784 cents	Average time to assemble 18 unit parts to form clutch No.31531	Women Boys and Men	8	40

Chart showing System followed in Assembling Operations

paper abstracted in the following analyzes and illustrates all the elements which should enter into the producer's calculations and outlines the works organization necessary to secure rapid and economical production. It describes the results obtained in the assembly of given pieces and the place that preliminary time and motion study has in assuring that the rived at by indirect means, that is by a tedious and intermittent process of elimination, trials and modifications which are based upon rough, occasional observations by the foreman and the employes in the shop. This course is costly, uncertain and slow, and expensive and inefficient methods adopted at the beginning are likely to be perpetuated. Instead of this method, any plant of moderate size engaged in light interchangeable manufacturing can afford to devote a small inex-

* Abstract of a paper by Mr. John Calder, published in the Journal of the American Society of Mechanical Engineers, January, 1911.

pensive department entirely to the task of deciding upon the operations to be performed and the best arrangement of apparatus and labor in the assembling.

Certain preliminary considerations must be held in view, such as the designing of the form of the parts so that they will lend themselves to rapid assembling processes; the designing and proper maintenance of efficient tools, jigs and fixtures; an efficient inspection system for the parts, securing in every department an adherence to the working limits; and the adoption of a system of routing the work through the shop in such manner that the fitting surfaces will be produced in such condition as to require the least work in assembling. The total abolition of the file or other cutting tools at the bench should be aimed at.

If these conditions have been properly observed, the assembly speed then depends upon the extent to which the division of labor is carried; the thoroughness of the time-study of skilled demonstrators, including the elimination of lost motion and a critical examination of the machined unit pieces; and the efficiency of the mechanical facilities provided for the assembling work.

If the various conditions outlined in the two previous paragraphs are fulfilled, by a suitable organization, for any new piece of work, before it is presented to the regular assemblers, and if the assembly work is accepted only after having passed an efficient inspection, then the straight piece-work system of remuneration is often found to be in the best interest of the employer and employe alike. When a preliminary study such as outlined has been made, there is no such margin remaining as obtains in the rough approximations of premium setting where the processes are left to evolve slowly and partly by chance. For this reason the employes may well be given the whole of the returns on the prescribed standard task.

In the accompanying chart is shown an example of the division of labor and the speed of workers on straight piecework tasks in the assembling of small interchangeable parts. All the conditions essential to the highest economy have been thoroughly worked out before the assembly task is presented to the manufacturing department. Owing to the minute division of labor and the elimination, by careful study, of all lost motion, most of the assembly stages in the chart, it will be noted, are performed in less time than it takes to describe them. In the works with which the author of the paper is connected, about 750,000 unit pieces of several thousand varieties are handled daily on the principles laid down in the chart. These total operations involve the use of about 20,000 piece rates, each based upon the results of exact preliminary time and method studies.

In the assembling operations the file is conspicuous by its absence. The possession or use, by any assembler, of this mechanical persuader towards a fit is forbidden, unless due cause is shown and special permission given. It has been found that such a prohibition often throws a considerable amount of new light upon the condition of the machined surfaces prepared in other departments, and passed according to the prescribed gage tests. The general result of this course is to raise the whole level of machine shop practice and to help in locating definitely the needed refinements and corrections in the design of jigs and fixtures.

The method pursued in definitely determining the various operations as outlined in the assembly charts are as follows: Prior to the introduction in the shops of any new assembly operations, the prescribed apparatus which is the best that the collective experience of the superintendent, foreman and tool engineer can devise, is handed over to the time-and-motion-study department, whose few expert employes proceed to operate it on a manufacturing basis. They handle large quantities of product which is subject to all the usual inspection tests, and which pass into the regular manufacture of the plant. In this way, the cost of the time study department is reduced to a small figure, because the working time of its experts is fully as productive as that of the shop. The few experts have been selected and organized from the ranks of the ordinary shop employes, those having been selected who have shown considerable versatility and the power of comparative observation. When any suggestions of value as to the apparatus and parts supplied have been put into effect, this department determines the following questions:

1. Best height and position of the seat or chair of the operator at the bench or machine.

2. Best position in front or on the right or left of the operator of the pieces to be handled.

2. Best position—in front or on the right or left of the operator—of the pieces to be handled.

4. The advantage, if any, of an ambidextrous operator, and the cultivation of that faculty.

5. The best arrangement for bringing forward and removing the work without interrupting the assembly process.

6. Time study of each of the movements finally decided upon as necessary, and the combination of all of them on the principle of "least work."

When these questions have been fully settled, a straight piece rate is fixed, based upon the investigation made. The rates are so fixed that they will give an industrious worker with average ability an opportunity for normal earnings, while the exceptional operator receives the full amount of his surplus output. In the works with which the writer is connected the entire study staff consists of only six members. The restriction of the shop foremen to solely productive supervision is not favored, but they are encouraged to compete freely with the time-study staff for best results. The cooperation with the foremen is always of the highest value and enhances their administrative ability.

* * *

LEGAL DECISION RELATING TO ELECTRICAL INTERFERENCE

In view of the efforts at the present time to curb amateur wireless telegraphers and the protests of the latter against monopoly of the atmosphere by commercial and government stations, it is interesting to note, says the *Scientific American*, the decision recently handed down in the case of the Lake Shore & Michigan Southern R.R. Co., the Postal Telegraph-Cable Co., and the Western Union Telegraph Co., versus the Chicago, Lake Shore & South Bend R.R. Co. Suit was brought against the latter company because its 6600-volt single-phase trolley line affected inductively the lines of the telegraph companies and the signal system of the railroad company. The court held that the use of single-phase alternating current on one's own premises does not constitute a nuisance, even though the electricity may escape and interfere with the operation of electrical devices on adjoining property; that the companies by bringing suit held no monopoly of the atmosphere; and that if they found their systems interfered with, they should provide such mechanical or electrical devices as would protect their lines.

* * *

CHROMAN-BRONZE—A NEW BEARING METAL

That the addition of a small amount of chromium to nickel alloys imparts some very marked and valuable properties to the latter, was the recent discovery of James Naulty and John Scanlin, of Philadelphia, Pa. It was found that if about 5 per cent of chromium is added to an alloy of copper, nickel and zinc, not only is a strong and non-corrosive mixture obtained, but one that makes an excellent bearing metal. This alloy has been patented under the name of "chroman-bronze." It is made from pure metallic chromium by a secret process, and has the following properties: It is white and capable of taking a high polish; has the toughness of cold-rolled shafting; is capable of resisting acids to a marked degree; and is immune to the action of salt water. Tests of sand castings show a tensile strength of 78,950 pounds per square inch.

* * *

The British Engine, Boiler and Electrical Insurance Co. states that in 1909 of the total number of breakdowns of dynamos and motors insured, one-fourth of the cases were caused by dirt and neglect, one-fifth caused by the age and deterioration, and one-fifth by poor workmanship and design of the machinery.

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SOME EXAMPLES OF MODERN DIE WORK

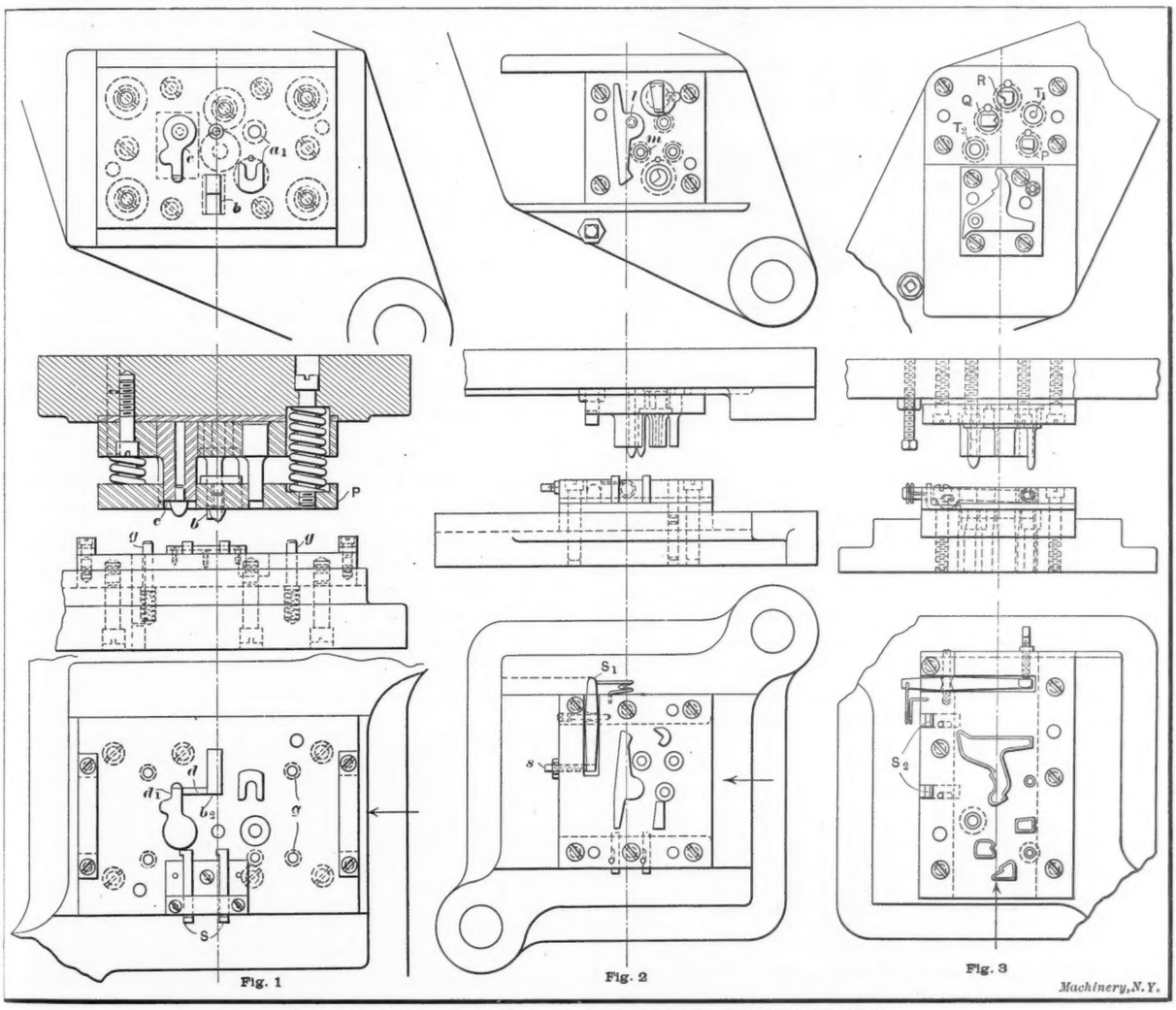
By FRANKLIN D. JONES*

Some interesting examples of die work taken from the die-making department of the Taft-Peirce Manufacturing Co., Woonsocket, R. I., are shown herewith. While the dies illustrated are used to produce comparatively plain parts, there are some points in their construction which may be of interest and value, particularly to those not experienced in the art of die making.

The die shown in Fig. 1 is for producing the part illustrated at *A* in Fig. 4, which also shows the successive piercing, bending and blanking operations. The stock is fed through the die in the direction indicated by the arrow. On the first stroke the piercing operation at *a* is performed by the punches a_1, Fig. 1. On the next stroke the bending punch *b* turns over the part b_1, making a right-angle bend, and, finally, the finished piece is blanked by the punch *c*. Of course these operations all take place simultaneously, except when the stock is first being started, so that a finished piece is blanked out at each stroke. One of the interesting features of this die is the method of stopping the stock as it is fed forward. After the bending operation, which takes place at b_2 on the die, the bent end b_1 which projects downward below the surface of the die, is fed forward through channel *d* until it comes against the end d_1 which forms a positive stop. By this simple method, the stock is located for the pilot pins which accurately position it for the blanking operation. By means of the spring pressure-pad *P*, the stock is held firmly against the die, so that it will not be ouckled by the bending operation. When the stock is first being started through the die, stops *S*, which may be moved in or out as required, are used for locating the stock for the first and second operations.

The die shown in Fig. 2 is for piercing and blanking the pawl illustrated at *B* in Fig. 4, which also shows a sample of the scrap. As the V-shaped projection *h* on one end of this pawl, and the straight surface *i*, had to have a smooth finish, a shaving operation on these surfaces was required. This operation is not performed in a shaving die after blanking, as would be necessary if the entire contour of the part had to be finished, but it is done in the blanking die by removing a certain amount of metal adjacent to these surfaces, as at *j* and *k*, during the piercing operation. The result is that when the pawl is blanked, the edges opposite the openings *j* and *k* are subjected to a shaving action which leaves a smooth surface that is entirely free from the roughness found on the other edges where the stock is sheared from the solid. The narrow shavings which are removed from the surfaces to be finished, remain attached to the scrap in this particular instance, as the illustration shows. It will be seen that when this methou of securing a finished edge is employed, the stock must be accurately located, as the removal of a shaving that is too thick would roughen the edge. In the die illustrated, the stock is located by the two pilot pins *l* and *m*, the former entering the hole *n*, Fig. 4, and the latter a hole *o* pierced simply to give a two-point location, thus insuring accuracy. In practice it has been found that a shaving equal to 10 per cent of the stock thickness, is about right for mild steel.

This die is equipped with an automatic stop S_1 which is operated by a projecting screw on the punch in the usual way. The hole in this stop for the pivot on whicn it swivels, is tapered toward the center from both sides, as shown in the detailed view, Fig. 5, thus giving it a movement horizontally



Figs. 1, 2 and 3. Punches and Dies for Producing the Parts illustrated in Fig. 4.

* Associate Editor of MACHINERY.

as well as vertically. With the stop mounted in this way, slight adjustments to compensate for any error there might be in the location of the stop with reference to the pilots in the punch, can be easily made when the die is being tried out, by simply turning the screw *s* until the stop is properly positioned. The function of the stop is, of course, to locate the

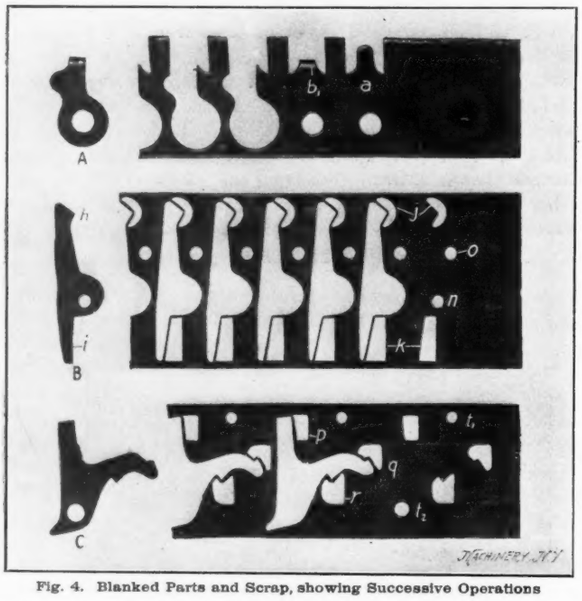


Fig. 4. Blanked Parts and Scrap, showing Successive Operations

stock approximately and its flexibility prevents the pilots from being subjected to any strain. This horizontal adjustment has an additional advantage in that the stop does not have to be located so accurately when this adjustment is provided.

Another punch and die of the piercing, shaving and blanking type is shown in Fig. 3. In this case the work *C* in Fig. 4 had to be finished in three places, as shown by the perforations at *p*, *q* and *r*. The stock, which is fed in the direction of the arrow, is pierced for shaving by the three punches *P*, *Q* and *R*, while punches T_1 and T_2 pierce the holes t_1 and t_2. The hole t_1 is merely for locating purposes, there being two pilots which give a two-point location. This die is also equipped with an automatic stop similar to the one illustrated in Fig. 5, and it has small hand stops S_2 which are also common to the designs previously referred to.

Fig. 6 shows a sectional view of a swaging die which performs, simultaneously, two swaging operations on the small ratchet shown at *C*. This ratchet has a square projection on one side, as shown, and four small projections *k* in a tapering part of the hole on the opposite side. The latter serve as keys and retain a tube to which the ratchet is attached, against rotary movement. The work as it comes to this die is in the form of thick washers as at *A*. The blank is located by the pilot on the swaging punch *S* and is firmly held by the spring pressure-pad *P*, which, as the punch descends, brings up against the punch-plate P_1, thus compressing the metal into the square pocket above plunger *p* which descends, against the tension of a spring, until it bottoms against the bolster plate. While the square is being formed in this manner, the tapering part of the swaging punch is countersinking and forming the small key-like projections *k* in the hole. The blank as it comes from this die is shaped as at *B*; it is then blanked out in another die in which it is located by the square previously formed, thus bringing both the square and the hole central with the ratchet teeth.

A die of the sub-press type is illustrated in Fig. 7, which is used for blanking the part shown at C_1. The stock A_1 is first flattened out as at B_1 and a small projection *b* is swaged by a punch that forces the metal into a pocket of the required shape, in the die. After this swaging operation, the work is blanked as at C_1 in the die shown in Fig. 7, in which it is located by the projection *b* which fits into a pocket. The part

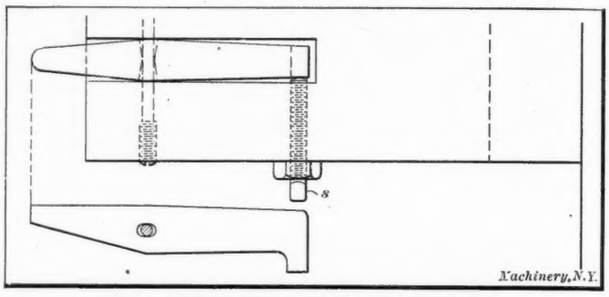
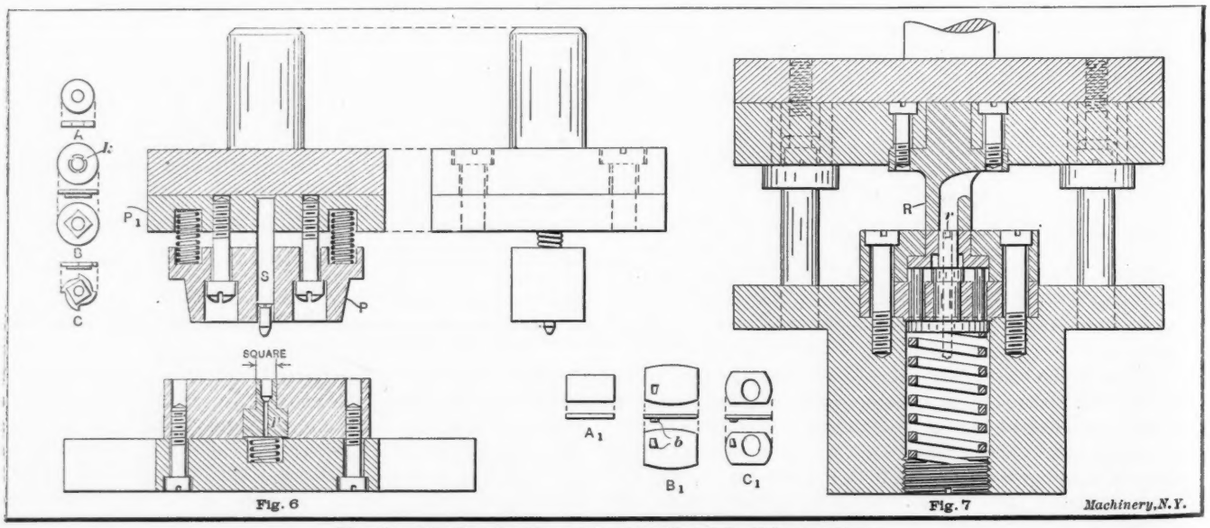


Fig. 5. Automatic Stop with Horizontal Adjustment

is blanked by the punch *R* and pierced by punch *r* which forces the scrap up through the opening shown in the blanking punch.

* * *

In a paper on street traffic conditions in London, read before the Institute of Mechanical Engineers (Great Britain) Mr. L. A. Legros, as reported by the *Engineering Record*, stated that *congestion of traffic generally takes place in districts where land values are high*, and he considered the condition anomalous that tenants pay extremely high rates for offices in the same localities where traffic regulations put a premium on very slow vehicular movements. Mr. Legros' discovery is indeed most atsonishing, so much so in fact, that it puts us in mind of an old Swedish poem written some 150 years ago and entitled "Remarks of the Blessed Fool" in which he sagaciously comments on the extreme wisdom and foresight of Providence "who made great rivers flow, where later great cities were to grow."



Figs. 6 and 7. Swaging Die and Blanking Die of the Sub-press Type

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AUTOMATIC LATHE WORK*

In machine tool work the development of automatic machinery has been somewhat slower than in a great many other industries, due to the fact that there has been a considerable variety in the product dealt with, and hence the number of similar pieces has been too small to call for automatic machinery except in the case of ordinary small screw work. The tendencies toward a higher degree of specialization which have become pronounced during the last few years, have, however, brought with them a development of other automatic machine tools, especially the automatic lathe or turning machine—by which is meant an automatic machine for turning, boring, and facing operations on detached pieces of work, as distinguished from work made from a bar. Such detached pieces may be castings, forgings, stampings or blanks previously cut off from the bar on a cutting-off machine.

Development of Automatic Turning Machines

The earliest machines for this work were simply converted automatic screw machines, and the work, which was generally castings, was fed automatically into the chuck from a magazine attachment. As the advantages of this kind of machine became obvious, a demand arose to use them on larger articles, but experiments with magazines for large work have not been successful. In the place of a magazine, what is known as a transfer chuck is frequently used, this transfer chuck consisting of a spring holder into which the work is placed by hand. At the proper point in the cycle of operations, this transfer chuck places the article in the automatic chuck on the spindle of the machine. An attendant is, of course, then required to go around from one machine to another feeding the chucks, the machine of course, running continuously.

The difficulty of holding rough castings varying in size has been overcome in some cases by the use of spring chucks, in others by the use of compressed air. In a type of chucks of a design recently brought out and successfully operated, the irregularities in the castings are compensated for by using a system of automatic spring-operated wedges. All these devices have been successful on work of moderate size, but no one would attempt to hold, say, an 18-inch casting in an automatic chuck, and on such large work hand chucking is used. This is not a marked disadvantage, because in the case of large pieces, the actual time required for the chucking is usually only a small fraction of the time required for the whole work, so that but little time could be saved by automatic chucking.

Comparison of Cost of Work done on Engine Lathes, Turret Lathes and Automatic Turning Machines

One question to be answered in regard to automatic turning machines is whether work can be done on such a machine quicker than in an ordinary hand-operated turret lathe, and in reply to this question it may be said that on work for which the turret lathe and the automatic machine are both set up in the best way, the time is estimated to be approximately the same for both machines for each piece, but in the ordinary every-day practice the output of the automatic turning machine, per day or per week, would materially exceed that of the turret lathe. There are two reasons for this, the first being that the automatic turning machine, when once set up, works at the same rate all day without getting "tired" and without suffering from any of the usual casual interruptions which interfere with the output of a hand-operated machine; the second reason is that in actual practice the turret lathe is seldom set up as efficiently as it might be, whereas the automatic turning machine must be set up more or less correctly in order to do its work at all, and, th refore, in itself, exercises a kind of automatic discipline on the operator, which is absent with a hand-operated machine. As a general estimate it may be said that work which will take four hours on an engine lathe and one and one-half hour on a turret lathe, can be produced in one hour on an automatic turning machine.

Of course, the fact that work can be turned out quicker on this machine does not in itself prove its economy. In order to determine the question of cost, the prices of the machine and of labor, depreciation, and running expenses, must be considered. On an average it may be said that the prices of engine lathes, turret lathes and automatic turning machines, properly equipped with standard tools, are in the ratio of 100 to 350 to 450. The interest and depreciation allowances are in the same ratio. If the time to do certain work is assumed to be in the ratio of 4 to 1½ to 1 in the three machines, and it is assumed that one operator can handle four automatic machines, then the labor cost per piece will be in the ratio of of 4 to 1.5 to 0.25. If all the factors are thus considered it is found that the ratio of cost of labor, interest and depreciation for engine lathes, hand-operated turret lathes and automatic machines is in the proportion of 4.5 to 2.1 to 0.8, approximately, for each piece of work, which is strikingly in favor of the automatic turning machine. Of course, it is to be understood that these results can be obtained only when a considerable number of duplicate parts are to be made on the automatic machine, so that the cost of setting up the machine becomes a very small item per piece.

Makers of automatic turning machines have frequently been charged with using, too freely, glowing descriptions of the economy of labor cost, and carefully avoiding any reference to machine and tool charges, but the proportions given above show that even after allowing for machine and tool charges the same as for other machines, these charges amounting to more than twice the cost of labor in the calculations leading up to the ratios given, the economies resulting from the employment of machinery of this class on suitable work are too great to be overlooked. The economies are so great that automatic machines may properly be employed even where the relative figures for hand and automatic machines would vary largely from those assumed above. For instance, even if the costs upon which the author has based his calculations were doubled, there would still be a saving in the use of the automatic machines.

The running expenses charged against the work include such items as the floor space occupied, the power consumed, the amount of repairs, the cost of tool renewals and the cost of supervision. In this respect the three machines appear about as follows: The automatic turning machine occupies less floor space per unit of work than the engine lathe and somewhat less than the turret lathe; the cost of power *per unit of work* will be about the same for all three classes of machines, and the same applies to the question of repairs. The cost of tools, of course, will be higher for the automatic and the turret lathe than for the engine lathe; but a sum of $50 a year per machine spent for additions to the original outfit of standard tools would mean less than two cents per hour in running expenses, which is not enough to seriously affect the savings due to the use of the machines.

Requirements for a Successful Automatic Turning Machine

The requirements of a successful automatic turning machine are more exacting than those of automatic screw machines on account of the great variety of work and materials for which the machine is made. The automatic turning machine consists essentially of a turret lathe in which the chucking is performed by hand, but in which all operations required for the performance of the work proceed automatically. It should be possible to start the spindle by hand without starting the automatic movement so as to be able to test whether the work runs true in the chuck before the machine begins to operate. The chuck must be exceedingly strong and powerful on account of the number of tools which may be operating at the same time.

The spindle gearing should have automatic speed changes for different cuts on the same piece of work. All tools should have independent feeds so that if one tool should happen to be feeding too fast, the reducing of that feed does not reduce the feed of all the other operations, which would seriously reduce the output of the machine as a whole. The turret should be strong enough to carry very heavy tools, should index without shock, and should be clamped after indexing. The cross-slides should be capable of independent adjustment along the bed, and every tool movement should have its own

*Abstract of a paper read by Mr. P. V. Vernon before the Rugby Engineering Society (England), November 10, 1910.

adjustable dead stop. The spindle of the machine should be capable of reversal when required.

A most important point, and one which is overlooked on too many machines of this class, is the provision for automatic lubrication. When an operator has a number of machines under his charge it is clear that he has not a great deal of time to attend to oil holes and lubricators all over the machines. The headstock and other gears should preferably run in oil, and all bearings should be of the self-oiling type.

Another point sometimes overlooked is the provision of means for stopping the machine should anything happen to any of the tools. A tool may occasionally break during the operator's absence, and in such a case, means should be provided so that the breakage is confined to this tool and is not followed by a breakdown of the machine itself. Some form of slipping device should be used for this purpose, and the simplest form of such a device is to drive the speed motion and the spindle of the machine by means of belts which would slip and be thrown off in case of accident.

General Considerations

Attention may profitably be called to the material to be machined. An occasional hard casting in a lot may necessitate slowing down the machine for every casting with a consequent decrease in output. The same may be said of castings which are irregular, as the machine must, of course, be set for the outside dimensions of the largest pieces; hence time is wasted on all the castings on account of an occasional lump on one. The user of automatic turning machines, therefore, can increase the output of these machines by inaugurating some improvements in his pattern shop and foundry, and the time spent in these places will be regained over and over again in the machine shop.

Cast-iron articles should be annealed, and when this is done they may be made of a much harder grade of cast iron, and hence are stronger, but as easily machined. Castings should also be pickled to save tool grinding. Most of these recommendations are applicable to work machined by any method, but are especially necessary when continuous running is aimed at, as in automatic turning machines.

Lastly, looking at the question of the desirability of automatic turning machines from the workman's standpoint, it may be said that their use enables reasonable wages to be paid, and there is more change, variety and opportunity for mental exercise in the running of four machines by one man—all, perhaps, employed on different jobs—than there is in the operation of an ordinary engine lathe using a single cutting tool.

* * *

The Bureau of Steam Engineering, Navy Department, Washington, D. C., has recently issued new specifications covering the composition of metals and materials supplied to the United States Navy Department. The specifications cover the composition of commercial brass, Muntz metals, brazing metal, gun-bronze, journal-bronze, valve-bronze, ingot-copper, manganese-bronze, monel-metal, cast naval brass, phosphor-bronze, screw pipe fittings of brass, metallic nickel, tin, lead, thrust-rings, monel-metal ingots, admiralty metals, benedict-nickel, sheet brass and tubing, brass rods, copper, manganese-bronze and rolled naval brass. The specifications also give the required tensile strength, yield point and elongation of the various metals, together with other general information relating to the tests to which the metals are subjected in order to determine their qualities.

* * *

As a result of recent tests, Prof. F. M. Goss estimates that of 90,000,000 tons of coal consumed by 51,000 locomotives in the United States in 1906, 720,000 tons were lost through incomplete combustion of gases, more than 10,000,000 tons were lost through the heat of the gases discharged through the smokestack, more than 8,600,000 tons were lost through cinders and sparks, and the equivalent of nearly 3,000,000 tons were lost through unconsumed fuel in the ashes. These figures indicate the economy that might be possible with improved furnaces insuring more perfect combustion.

MACHINE SHOP PRACTICE

HAND SCRAPING

By H. P. FAIRFIELD*

Hand scraping in metal working is done to accomplish three specific objects:

1. To produce an ornamental surface for the sake of appearance only. This is known in shop nomenclature as "frosting," "snow-flaking," or under the general head of "spotting," and consists in using the hand scraping tool in such a way as to obtain "spots" upon the surface to be ornamented. The

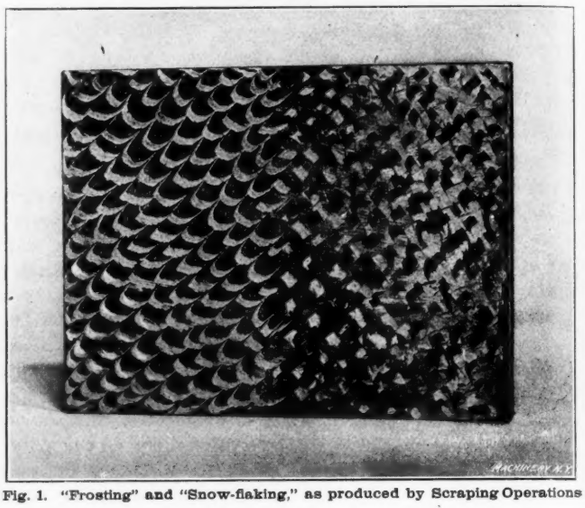

Fig. 1. "Frosting" and "Snow-flaking," as produced by Scraping Operations

spotted surfaces, as shown in Fig. 1, are of two kinds, one having small square spots arranged as indicated, and one having "half-moon" spots. The former is termed "snow-flaking," and the latter "frosting." In the former, the scraping tool is pushed squarely ahead to give spots of an established size and at established intervals. Similar spots are then made to fill the intervening spaces, using the scraper at right angles to the previous direction of motion or push. Frosting is accomplished by giving the scraping tool a peculiar "wiggle," as the cut is made; this is not easy to do, and dif-

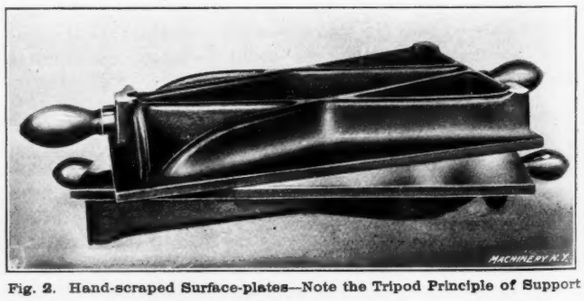

Fig. 2. Hand-scraped Surface-plates—Note the Tripod Principle of Support

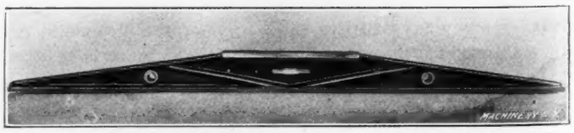

Fig. 3. Hand-scraped Straightedge; when not in Use, it is supported from the Holes shown, to prevent Unequal Stresses

ficult to describe. However, if well done, it leaves a very handsome finish. A surface ornamented in this manner may have been most carefully hand scraped to an accurate and precise plane, or it may have been left as it came from the machine. Ornamenting by spotting a surface that has been hand scraped, is done to give a regularity to the impressions left by the tool. When a surface is ornamented without previous hand fitting by scraping, it may be done wholly as an ornamentation or, as is sometimes the case, to deceive the uninitiated, who are apt to consider it as proof of previous careful fitting.

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2. To fit two surfaces to each other more accurately than they can be fitted by machining. Examples of this kind are seen in such bearings as spindles and their boxes, in cylinders where a solid piston must fit without the presence of high spots or ridges on the surfaces, and in cases where it is impossible to use machinery for smoothing or finishing surfaces. An example of this latter case may be seen in repair jobs on babbitt-lined bearings, replaced in localities distant from all shop conveniences.

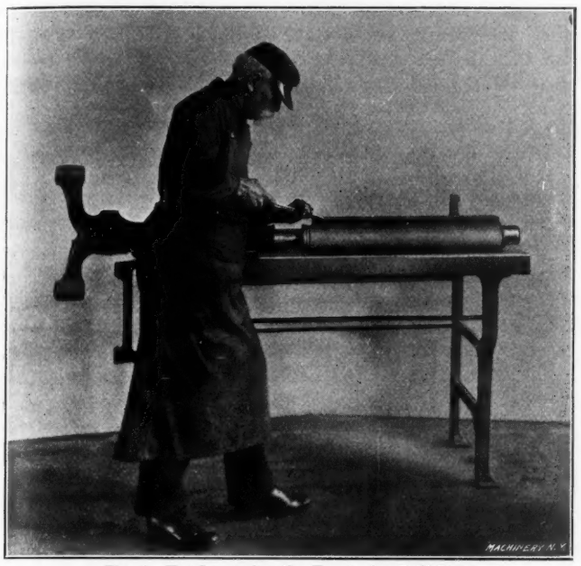


Fig. 4. Hand-scraping the Front of a Drill Post

3. In the case of plane surfaces, where the surface is finished by hand scraping to conform to a previously prepared master plane surface, termed a surface-plate. The hand scraping of plane surfaces is undoubtedly one of the most skilled of the regular machine shop operations, and is always performed by a specially trained corps of employes. Perhaps the art of hand scraping plane surfaces can be illustrated in no better way than by describing the methods of producing a master surface-plate.

Commercial firms that produce standard surface-plates for sale have a large master plate to which all the master plates used by them in producing surface-plates can be referred. This plate, which might be termed "an original master plate," is used for test purposes only, and cared for as religiously as possible. Where no master plate is available for test purposes, it is necessary to make three plates if but one is desired. This is easily understood if one considers that two curved surfaces can be made to fit each other, but that a third surface could not fit both the curved surfaces. In other words, a surface cannot at the same time be concave and convex. Therefore, if each of three surfaces or straight edges will match each other, they must all be straight or plane surfaces.

Surface-plates are usually made from gray iron castings. The pattern is made with uniform ribs upon the back or under side, as shown in Fig. 2, if it is to be finished upon one side only. (If it is to be finished upon all sides, as, for example, a long bar of rectangular cross-section, it is built as a hollow box with suitable internal ribbing.) Besides having ribs, the under side is provided with three bosses used as feet, as shown, for resting the plate upon the bench or other support. These feet are so located as to evenly support the weight of the plate, and it should, at all times, whether in use or not, rest upon these spots. The castings are first rough-planed to approximately the finished size, and allowed to season for a period of several months that all internal cooling strains may adjust themselves. This process can be hastened somewhat by heating in an annealing oven, if care is used not to overheat. When suitably seasoned, a light finishing cut is made on the surface to be scraped, and a seasoning period is again allowed. Each plate is then carefully scraped to a smoothly finished surface, taking care to remove even amounts all over each surface. They are then scraped to fit one another by placing one upon another and rubbing the surfaces together until the high spots on each plate are located, and then scraping these off.

As an aid in locating the high spots upon the surfaces in contact, use is made of some pigment, as for example, venetian red. A thin film of this is rubbed over the surfaces before placing them together. The points at which the two plates touch are thus readily indicated. The workman with his hand scrapers removes a small amount of the stock at the indicated points, and repeats the process of locating the high points of contact between the several plates and afterward scraping them off, until the surfaces are interchangeable each with the other and are completely "freckled" over their upper surfaces with points of contact. These points of contact should be uniformly distributed over the entire surface, and the fitting should continue until at least 60 per cent of the surface of the plate is in contact with its mates. Evenness of distribution is of prime importance, as is also the requirement that all parts of the surface not actually in contact shall be an unmeasurable distance below the level of the parts which actually are in contact.

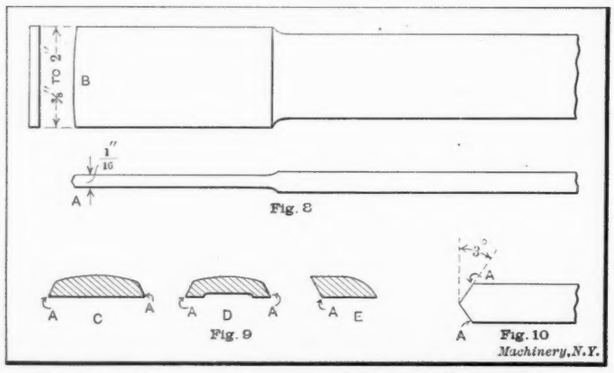
Fig. 5. Method of Holding a Scraper

Fig. 6. Honing a Scraper

Fig. 7. Honing the Scraper on the End

For this class of hand scraping and for the spotting processes first described, tools resembling in outline a file, are ordinarily used, held as shown in the accompanying illustrations, Figs. 4 and 5. They are ground square across the end and are afterward honed upon a hard oilstone. When the honing is being done, they are held in a vertical position and inclined alternately to the right and to the left about 3 degrees. (See

Fig. 7.) The cutting edges are thus given a negative rake of 3 degrees, and the tendency to chatter in use is reduced. In this, as in all other purely hand operations, the personal element is supreme, and the difference between workmen in respect to quality and quantity of production is very marked. Fig. 4 shows a workman hand scraping the front of a drill post for its table and spindle brackets. In work of this character the surface-plate, or straightedge, Fig. 3, is placed upon the surface being scraped, but in the case of small pieces, the work is rubbed upon the plate instead. Whichever is done,



Figs. 8, 9 and 10. General Appearance, Sections and Enlarged View of End of Hand Scrapers

the surfaces should be carefully wiped to remove loose particles, and a light coating of pigment given them.

Hand scrapers, as shown in Fig. 11, resemble files in form and are often made from old files. This is not, however, good practice, and new special stock should be used. They are hardened glass-hard on the cutting edge and not "drawn" afterward. Then the cutting end is ground and honed upon an Arkansas oilstone, as already mentioned, leaving a cutting

Fig. 11. Collection of Hand Scrapers for Flat Surfaces and for Journal Bearings

edge as shown exaggerated in Fig. 10. In use, the hand scraper is held at a sufficient angle with the work to make it "bite" the surface, and is then pushed from the workman along the surface being scraped. The length of stroke varies from that of several inches, when roughing off the surface, to almost no distance when the finishing touches are being made.

Flat hand scrapers vary in size to fit the jobs on which they are used. The usual range is from ⅜ inch wide by 6 inches long, to 2 inches wide by 24 inches long. The ordinary size used on machine tool work is about 1 inch by 18 inches.

The curved scrapers shown in cross-section in Fig. 9 are used in finishing spindle boxes. Scrapers of this type are of a variety of cross-sections. They are used by pushing or pulling with a combination motion both around and lengthwise of the bearing.

In Fig. 8 is shown the ordinary flat hand scraper. It will be noticed that there is a slight curvature at the end *B* of the tool. In Fig. 9 are shown cross-sections of scrapers for spindle boxes, as mentioned; *A* represents the cutting edge in all cases. The cutting edges make an angle of from 3 to 15 degrees with the vertical. The cross-sections at *C* and *D* are for scrapers for roughing, and that at *E* for finishing spindle boxes.

* * *

FIVE YEARS OF MACHINE TOOL TRADE

The accompanying chart is based upon the sales of the Frevert Machinery Co., 18 Dey St., New York City, dealers in machine tools. The chart shows the variations in the business activity of this firm during the past five years, and it

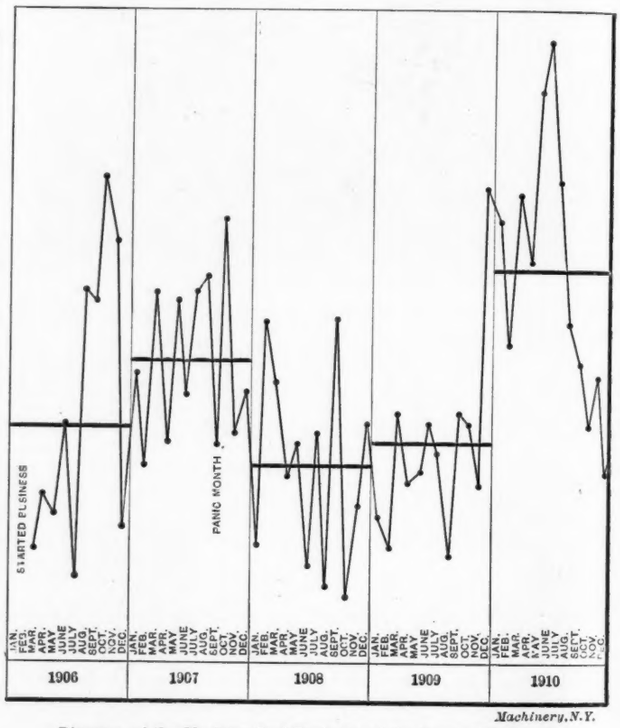


Diagram of the Machine Tool Business of the Frevert Machinery Co., New York

may be reasonable to assume that this diagram in a general way indicates the state of the machine tool business throughout the country during this time. The heavy horizontal lines show the average yearly sales for these five consecutive years.

* * *

PEAT AS A FUEL FOR LOCOMOTIVES

The experiments undertaken in Sweden to determine the possibilities of peat as a fuel on locomotives have now been completed, and the State Railway Department reports that the attempts have not been successful. It has been found in these experiments, as well as in experiments und rtaken elsewhere, that while theoretically 1.64 ton of peat is equivalent in heating value to one ton of coal, it was practically necessary to use 1.95 ton of peat to one ton of coal. The result is that, at the present time, the cost involved in the use of peat fuel exceeds that of using coal. It is evident that while the increased weight and bulk of peat for use on locomotives is a serious objection, apart from its cost there would be no such objection to its use in stationary power plants. The problem of how to get the peat into a state where it is suitable as boiler fuel without incurring excessive cost in the operations necessary for its preparation, eems, however, still to be unsolved.

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DRAWING DEEP CYLINDRICAL SHELLS

By SIRIUS

I was much interested in the article which appeared in the December number of MACHINERY on drawing deep cylindrical shells, and the auxiliary-punch idea is one that will find a place in my note-book.

The ratio as given between the diameter of the blank and the diameter of the first cup seems to me to be rather low, judging from my experience which has been mostly on small work and on work where the ratio between the thickness of the metal and the diameter of the blank is not so great. The ratio between the thickness of the metal and the diameter of the blank in the case referred to, is 1 to 368. With a greater ratio—1 to 475—that is, with stock which is 0.015 inch thick and a blank 7⅛ inches in diameter, it was possible to draw a cup nearly 4 inches in diameter. This gives a ratio of approximately 1.8 between the diameter of the blank and the diameter of the first cup. In a certain case where the stock was slightly thicker in proportion to the diameter of the blank than that given, a ratio of 2 was used successfully. The stock in this case was a composition of tin plate on a base of special-quality open-hearth steel, and the dies were well fitted to a toggle-press which had a smooth action. This leads me to believe that the ratio of 1.6, as given by Mr. Davis, is too low.

Referring to the redrawing operations, Mr. Davis states: "The reduction of the shell in this and the successive operations is determined by practical experience more than anything else, as it is a very difficult proposition to know just exactly how much the metal will stretch under varying conditions." I have not found this to be the case. Redrawing operations are as simple as plain drawing operations, and for years I have used a ratio of 1.3 between the diameter of the cup and that of the shell in the first redraw, and also for the successive redrawing operations. In one case a ratio of 1.41 was used successfully for reducing, that is for reducing a portion of the body only, not for redrawing, which reduces the entire length to a smaller diameter. Where new stock is used, that is, metal that has not passed through a drawing operation, or been otherwise strained, the ratio can often be as high as 1.65.

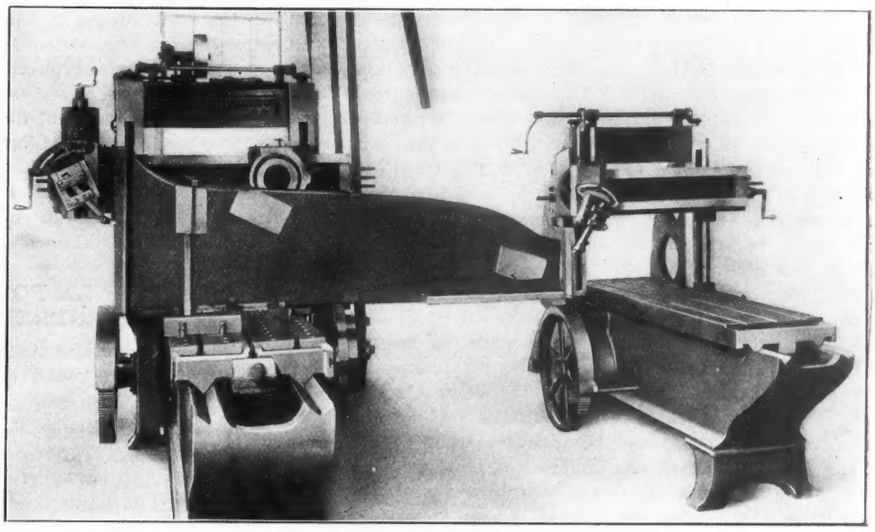
By calculating, it will be found that the ratios given by Mr. Davis for the redrawing operations are 1.23, 1.27, 1.23 and 1.25. This is close enough to 1.25 to show that this figure is practically constant and was probably used to determine the diameters for the successive redrawing operations. Perhaps the material used will not stand more, or probably this may be the limit under the specific conditions for this particular case, such as temperature, lubrication, conditions of dies and press, faulty heat treatment, excessive scaling or injurious pickling. Whatever the cause may be, a higher ratio could probably be used, but I would like to know the absolute limit which can be used under the best commercial conditions, as that is the most important factor.

Judging from my experience it seems that it would be possible to complete the drawing of the shell in four draws, eliminating one redrawing operation. This could be done by using a ratio of 1.3 for the there redraws which will give $(1.31)^3$, the index representing the number of redraws as well as the third power of the ratio. By multiplying the final diameter of the shell, 6 inches, by $(1.3)^3$ and dividing the result into the diameter of the blank, 23 inches, $\frac{23}{6 \times (1.3)^3}$ gives a ratio of 1.744 for the first draw—the making of the cup from the blank. Using this ratio 1.744 gives a cup 13.18 inches in diameter. Applying the ratio 1.3 for the successive redrawing operations, we obtain for the first redraw a shell 10.13 inches in diameter; for the second redraw a shell 7.79 inches in diameter; and for the third redraw, a shell 5.99 inches in diameter, or approximately 6 inches, which is the desired diameter of the shell.

* * *

AN INTERESTING PLANER JOB

The illustration shows a peculiar planer job recently met with in the Hoefer Mfg. Co.'s shops, 120 Jackson St., Freeport, Ill. This company built a cylinder boring machine for the automobile trade in which it was necessary to plane both the top and the bottom of the column, as indicated in the illustration. The widest planer in the shops of the company, however, was a 33-inch x 33 inch x 10-foot Cincinnati planer. As the column was over eight feet long, there was no way in which the top could be planed, as ordinarily set up on the planer. Beside this Cincinnati planer in the shop stood a 24 inch x 24 inch x 6-foot Gray planer, turned, however, so as to run in the opposite direction. After many methods had been thought of and discarded, it was decided to turn the Gray planer end for end into the position shown in the illustration. The column to be planed was then bolted rigidly to the table of the larger of the two planers, and then both ends of the column were planed with tools held as indicated in the half tone. Of course, the cut taken on the smaller end of the column was necessarily very light, because of the liability to chatter. A boy was placed at the feed lever of the small planer, as all belts had been previously removed. The small and large ends were then planed simultaneously, and the work was not only rapidly, but also accurately completed.



A Novel Method of Planing a Large Cylinder Boring Machine Column

* * *

STRENGTH OF OLD TIMBER

Tests undertaken by Mr. C. P. Buchanan on white pine show that sound timber a quarter of a century old is materially stronger than new timber. While the experiments were undertaken on white pine, there is no reason to suppose that oak, hard pine or any other wood commonly used in building construction would act differently. This is an interesting fact because ordinarily one would assume that new timber would be stronger. The differences in strength as found by Mr. Buchanan were quite remarkable. Where the average crushing load in pounds per square inch of new timber was 4260, the average strength of timber 25 years old, and which had been used in a wooden bridge, was 5300 pounds per square inch. While it may be assumed that the timber from the bridge was of a better quality than the new timber tested, and while this may be a correct assumption, it would hardly account for such remarkable differences in strength as shown by the figures quoted above.

"INS AND OUTS OF GEAR HOBBING"

An article by Mr. Ralph E. Flanders, entitled "Ins and Outs of Gear Hobbing," which was published in the January number of MACHINERY, page 369, engineering edition, has created wide comment, especially from manufacturers of hobbing machines. Mr. Flanders was for a number of years an associate editor of MACHINERY, leaving this paper last July to become connected with the Fellows Gear Shaper Co.; and some manufacturers have felt justly that his relation to the latter firm was not made plain in connection with the article, and that it appeared as an editorial opinion of MACHINERY, which was not the case.

We know Mr. Flanders too well not to believe that the opinions expressed represent his honest belief, irrespective of his business connection; but it is only fair that the readers of MACHINERY should understand the circumstances, and also that ample space and opportunity will be given for the presentation of the other side of the case.

* * *

THE SELDEN PATENT DECISION REVERSED

In the October, 1909, number of MACHINERY, the decision handed down by Judge Hough of the United States Circuit Court, upholding the famous Selden patent on gasoline engine automobiles, was referred to. The United States Circuit Court of Appeals on January 9, this year, reversed this decision, and overthrew the suit brought by the holders of the Selden automobile patent against C. A. Dueer & Co., the Ford Motor Co., the O. J. Gude Co., Panhard & Levassor, the Société Anonyme des Anciens, Andrew Masserbal, John Wanamaker and others concerned in the automobile industry. The Selden patent was granted in 1895 to George B. Selden, for an improved road engine.

The decision of the United States Circuit Court of Appeals was written by Judge Noyes. It describes, as the feature of the Selden automobile patent, the engine, inasmuch as the carriage element was ancient and the drive element dated back at least as far as 1879. Gas engines also were old then, according to the court, and liquid hydrocarbon engines, both of the compression and non-compression type, were no novelties. Practically speaking, there were two types of gas engines then in use, the so-called Brayton constant pressure engine and the Otto engine. Selden chose the former on which to apply the ideas that constituted his patent; later the Otto engine came in and superseded the Brayton engine. Judge Noyes declared that if Selden had based his patent on the Otto engine he would have obtained a grant that covered the modern automobile, but as he did not, the claim of the plaintiffs must fail. In his opinion he says:

"The patent was applied for in 1879 and granted in 1895. For over sixteen years the application lay in the Patent Office, and the applicant took full advantage of the periods of inactivity permitted by the rules and statutes. It is apparent that he delayed just as long as possible the issue of the patent to him. During this long time the automobile art made marked advances along different lines, and when, in 1895, the patent was granted it disclosed nothing new.

"Others had then made the patentee's discovery, and had reduced it to practice in ignorance of what he had done. While he withheld his patent, the public learned from independent inventors all that it could teach. For the monopoly granted by his patent he had nothing to offer in return. The public gained absolutely nothing from his invention, whatever it was. From the point of view of public interest it were even better that the patent had never been granted.

"It is urged that we should favorably consider the patent on account of the delay in the Patent Office, and should seek to avoid giving it a broad construction, and should permit the alleged abuse of the law to weigh against the standing of the complainants in a court of equity. But the patentee acted wholly within his rights. He merely took advantage of the delays which the law permitted him.

"He followed strictly the statutes and rules of procedure, and the courts cannot exact a greater amount of diligence from him. When the patent was granted under the law it became entitled to the consideration accorded to any other patent. If the statutes and rules permit unnecessary delays they should be changed, but we reject the view that this court owes any duty to relieve against their operation. This patent, even if it be useful only for tribute, must be viewed without prejudice and with absolute judicial impartiality.

"While the conclusion of non-infringement which we have reached leaves the patentee empty-handed with respect to the patent for the short time it has to run, it cannot be regarded as depriving him through any technicality of the first reward for his labors. He undoubtedly appreciated the possibilities of the motor vehicle at a time when his ideas were regarded as chimerical. Had he been able to see far enough, he might have taken out a patent as far-reaching as the Circuit Court held this one was. But, like many another inventor, while he had conception of the object to be accomplished, he went in the wrong direction.

"The Brayton engine was the leading engine at the time, and his attention was naturally drawn to its supposed advantages. He chose that type. In the light of events we can see that, had he appreciated the superiority of the Otto engine and adapted that type for his combination, his patent would cover the modern automobile. He did not do so. He made the wrong choice, and we cannot, by placing any forced construction upon the patent or by straining the doctrines or equivalents, make another choice for him at the expense of these defendants, who neither legally nor morally owe him anything.

"The decrees of the Circuit Court are reversed, with costs, and the causes remanded, with instructions to dismiss the bills, with costs."

Hence, according to the Court of Appeals, the Ford Motor Co. and the other defendants have never infringed the Selden patent. It is also interesting to note that the court finds that these companies gained nothing from the Selden patent when it actually came out of the Patent Office.

The Association of Licensed Automobile Manufacturers has announced that the Columbia Motor Car Co. and Mr. Selden are preparing to apply for a writ of certiorari with a view of having the case go to the United States Supreme Court for final decision.

* * *

TABLE OF LA POINTE STANDARD ROUND-CORNERED SQUARE HOLES

The accompanying table gives dimensions for what are called "standard round-cornered square holes," the standard given having been established by the Lapointe Machine Tool Co., Hudson, Mass. These holes are used for shafts of the square form, especially where sliding gears or other parts of similar nature are placed on the shafts, thus eliminating the use of keys. The reason why square shafts are not adopted to a greater extent than is at present the case, is to be found in the difficulty of producing square holes. The automobile business, however, has made the use of square shafts imperative, and holes made to the standard dimensions given in the table can be produced by the broaching machine and tools made by the Lapointe Machine Tool Co.

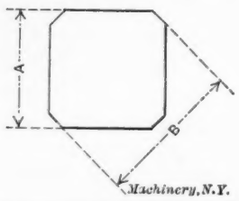


TABLE OF LA POINTE MACHINE TOOL CO.'S STANDARD ROUND-CORNERED SQUARE HOLES

No. of Square	Size of Square A	Size of Shaft B	No. of Square	Size of Square A	Size of Shaft B
1	1	1 1/4	10	1 9/16	1 15/16
2	1 1/16	1 5/16	11	1 5/8	2
3	1 1/8	1 3/8	12	1 11/16	2 1/8
4	1 3/16	1 7/16	13	1 3/4	2 1/4
5	1 1/4	1 9/16	14	1 13/16	2 5/16
6	1 5/16	1 5/8	15	1 7/8	2 3/8
7	1 3/8	1 11/16	16	1 15/16	2 7/16
8	1 7/16	1 13/16	17	2	2 1/2
9	1 1/2	1 7/8	..	...	...

* * *

At the annual meeting of the stockholders of the New York, New Haven & Hartford R. R. Co., last fall, it was decided to inaugurate a pension system for old employes.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

AN EFFICIENT CIRCULAR DRILL JIG

It is sometimes necessary to drill a number of holes in a circle at a certain distance from the center, and a jig which will be found very convenient for this class of work is shown in detail in the accompanying illustrations. It is not always an easy matter to set a drill concentric with a bushing when the jig is of large size and the drill small in diameter, as it is easy for the drill to be bent out of the perpendicular by the jig bushing, which condition, if slight, would not be noticed by the operator. Having had considerable work of this nature to do, the writer designed the jig shown herewith, which proved to be very satisfactory. This jig was originally used for drilling spanner holes in tight and loose collars. The assembled jig shown in Fig. 4 consists of very few parts. Fig. 1 is the baseplate, the bottom of which is recessed to give a good bearing on the table, so that the tightening of the bolts which clamp the jig to the table will not cause the plates to spring, which would bind the swivel.

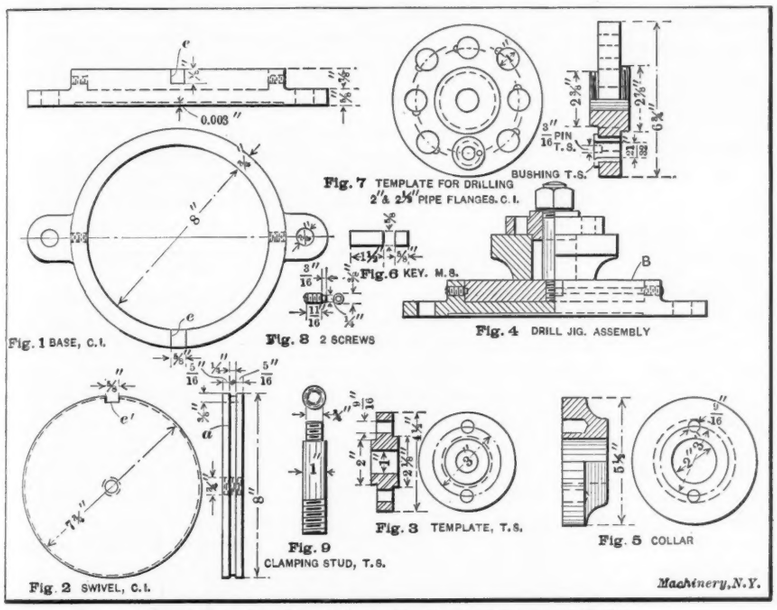


Fig. 1 BASE, C.I.
Fig. 2 SWIVEL, C.I.
Fig. 3 TEMPLATE, T.S.
Fig. 4 DRILL JIG. ASSEMBLY
Fig. 5 COLLAR
Fig. 6 KEY. M.S.
Fig. 7 TEMPLATE FOR DRILLING 2" & 2½" PIPE FLANGES. C.I.
Fig. 8 2 SCREWS
Fig. 9 CLAMPING STUD, T.S.
BUSHING T.S.
Machinery, N.Y.

Figs. 1 to 9. Details and Assembly Views of Circular Drill Jig

Fig. 2 is the swiveling part. This is turned to fit the baseplate and to insure its being true, the clamping stud, Fig. 9, must be first fastened into the swivel and both turned together. Ths slots *e* in the baseplate and *e'* in the swivel-plate are for the purpose of holding the two parts together with the key, shown in Fig. 6, when removing or putting the work in the jig, as the key keeps the jig from rotating when loosening the nut. The recess *a* in the swivel-plate is to facilitate the easy dismantling of the swivel-plate from the baseplate. The two headless screws, Fig. 8, are used for holding the swivel-plate in the baseplate, fitting in the recess *a*.

Fig. 3 is a templet made of tool steel and hardened which is used for centering both the tight and the loose collars in the jig. The collar shown at Fig. 5 is the loose collar and it can be seen how the boss on this templet is located in the hole so that the two 9/16-inch holes are spaced the correct distance from the center.

Fig. 4 shows the drill jig assembled ready for use. After the drill is set for the first hole all the movable parts of the drilling machine are tightened, and after this it is not necessary to loosen them until all of the holes are drilled. All that is necessary to drill the holes is to swing the swivel-plate *B* into the desired position when, if necessary, it can be locked with the small headless screws shown. This is a decided advantage in several respects over the ordinary drill jigs, and not only can holes be drilled more rapidly, but they can be drilled more accurately as well.

With the ordinary jig or templet the movable parts of the drill press must be left loose, and owing to this it is a difficult proposition to drill holes which will have the same center distances on both sides of the work. This means that to bring the holes back to their true relation they must either be filed or reamed, which is not a very practical way of doing such work. For the class of work just mentioned, the circular drill jig shown, overcomes these defects and can be used for a considerable range of work having two or more holes drilled in a circle.

The chief advantage of this jig is that the drill press table can be kept tight during the whole job, it only being necessary to move the swiveling-plate around to bring the jig into position for each hole.

Fig. 7 shows a templet which is applied to this type of jig for drilling pipe flanges. The templet shown here is for drilling 2- and 2½-inch flanges, one bushing being used for both sides. A templet of this kind could also be used to advantage for drilling bonnets, cylinder covers and small cylinders of varous sizes by using interchangeable bushings to fit over the stud.

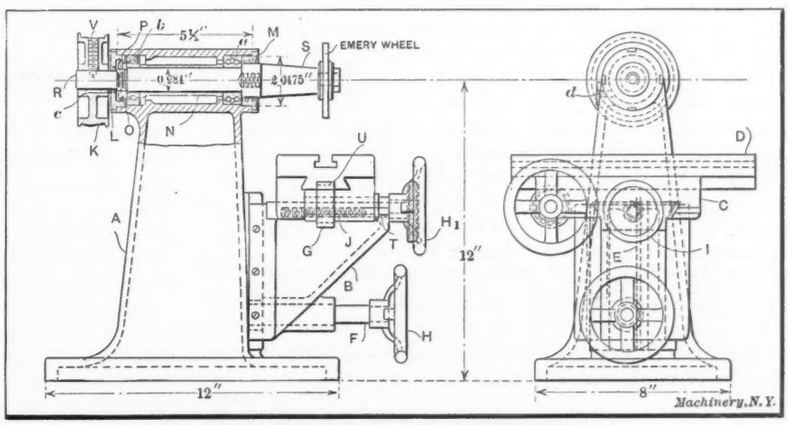
By graduating the baseplate of this drill jig into 360 degrees, templets and jigs can be drilled, and their holes will be equally and accurately spaced.

JOHN W. BRANDLE

Jackson, Tenn.

A SMALL BENCH SURFACE GRINDER

The accompanying illustration shows a small bench surface grinder of improved design, which will be found very useful in tool-rooms where small work is to be ground. It is particularly adapted for typewriter, adding machine and cash register work, for grinding the small interchangeable parts composed in their make up. Although this grinder is limited to small work, it has a wide field of usefulness in the average tool-room.



Small Bench Surface Grinder equipped with Ball Bearings

The design of the spindle is out of the ordinary; and it is well supported and equipped with "New-Departure" bearings. The writer does not know of any grinder on the market in which the bearings shown in this design are incorporated. The forward bearing *a* is a double-row bearing, and takes the

end thrust as well as the radial thrust of the wheel, while the bearing *b* is a single-row bearing and takes the radial thrust of the pulley. The forward bearing has very little clearance between the outside of the bearing and the bore in the head, only 0.0008 inch being allowed. The rear bearing *b* is forced into the main casting or pillar *A*.

The knee *B* has two slides—a cross-slide *C* and a longitudinal or top-slide *D*. The knee is raised by the handwheel *H* fastened to the shaft *F*, the latter having a pinion attached to it which works in a steel rack screwed to the column *A*. The cross-slide is operated by the knurled knob *I* fastened to the screw *J*. The top-slide is operated by the handwheel H_1 through pinion *G*, held on shaft *T*. The pinion *G* works in the rack *U* attached to the top-slide.

The spindle *R* is made of a good grade of tool steel and is hardened and ground throughout. The bore in the bearing is made 0.002 inch larger than the spindle. A steel sleeve *N* is forced on the spindle between the two bearings. The bearing *a* is put in place and securely held by the bronze lock-nut *M*, the shoulder of the spindle pressing up against the bearing. The lock-nut *M* also acts as a dust cap to keep the emery from cutting into the bearings.

This grinder is driven by the pulley *K* which is 3½-inch diameter by 1¼-inch face, held to the spindle by a Woodruff key not shown and the headless set screw *V*. *P* is a locking-wire that goes three-quarters of the way around the lock-nut *O*, and thence into a keyway which is cut in the spindle. *L* is the dust cap for the other end of the head, and the recesses *c* are filled with packing. This not only keeps the dust out, but also keeps the oil inside the head. The oil is fed into the head from an oil cup (not shown) through a brass tube screwed into the hole *d*, thus keeping the spindle well lubricated at all times. *S* is an adapter or arbor screwed into the end of the spindle for holding the grinding wheels. For external work a 3-inch wheel can be used, and for internal work a smaller wheel can be used by making a smaller arbor.

Bristol, Conn. WALTER J. OLDROYD

CUTTING A MULTIPLE-PITCH WORM

In the department "Letters on Practical Subjects" of the November number of MACHINERY, a short article appeared under the heading "Cutting a Multiple-pitch Worm." The rule given in this article has its limitations, however, and cannot be universally applied. A better rule, and one that will work in all instances where it is possible to "catch" the proper thread by moving the carriage back a whole number of inches, is as follows: Multiply the pitch of the thread by a whole number which is either 1 more or 1 less than a multiple of the number of starting points of the worm and screw; and which, when multiplied by the pitch, gives a whole number for the product. It should be understood that by "pitch" is meant the distance from the center of one thread to the center of the next. The pitch must not be confused with the lead, which is the advance in one turn of the worm or screw.

As an example, apply this rule to the worm mentioned in the article in the November number. Here the lead was 2⅝ inches and the worm triple-threaded; the pitch then is 2⅝ ÷ 3 = ⅞ inch. We now multiply ⅞ by trial whole numbers which are not multiples of 3, until we obtain a product expressed as a whole number. We find that the first number by which we can multiply, and which complies with the conditions imposed, is 8. Thus ⅞ × 8 = 7, which indicates that if the lathe is stopped at the end of the cut and the carriage moved back 7 inches, we will enter the thread at its second starting point. If the piece of work is longer than 7 inches, we can move the carriage back 14 inches, 21 inches, 28 inches, etc., as required.

In some cases it is not possible to find a number by which to multiply the pitch which complies with the conditions and gives a whole number for the product. In such a case the cutting of a multiple thread by moving the carriage back a whole number of inches is impossible. Such a case, for example, is that of a triple thread with 1¼-inch lead; the pitch of this thread is 5/12 inch. We find that 5/12 cannot be multiplied by any number not a multiple of 3, that will produce a whole number. O. G.

GRIP CHUCK FOR A PRATT & WHITNEY HAND MILLER

We had a Pratt & Whitney hand miller and insufficient work to keep it going all the time, and we also were hard pressed for small capstan lathe work. One of the jobs wanted was a large quantity of key-pins *A*, shown in Fig. 1. These pins were driven under the shoulders of the studs to keep them from turning while screwing the nut on. One end of the key-pin had to be rounded, and a tool was used which rounded the end while cutting them off. To utilize the Pratt & Whitney hand miller for cutting off these pins a grip chuck, as shown in Fig. 2, was made. This consists mainly of a body *C*, sleeve *A*, cap *B*, and small spring chuck *E*, these parts being operated by the handle *F*.

The body *C* screws onto the nose of the spindle and is bored out tapering to receive the spring collet *E*, which has three

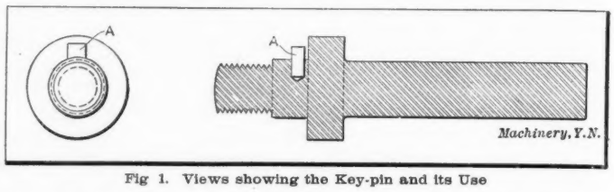


Fig 1. Views showing the Key-pin and its Use

tapered slots cut in it, so that the toggles *D* can be operated easily in them. A seat for the top of the toggles is made by beveling the edges of the sliding collar *A* and cap *B* as shown. The gun-metal pads *a*, shown fastened to the handle *F*, operate in the groove *b* cut in the sliding sleeve *A*. The outer end of this handle is attached to a bracket fastened to the machine (not shown) so that by pulling the gripping part of the handle the sleeve *A* is forced back and forth on the body *C*. It can therefore be seen that by sliding this sleeve back and forth, the toggles *D* are changed from an angular to a perpendicular position, and that when in a perpendicular position the chuck is closed.

A threaded washer *G* is provided to stop the movement of this sliding sleeve *A*, so that the toggles will be forced a slight amount past their perpendicular position. If this stop were

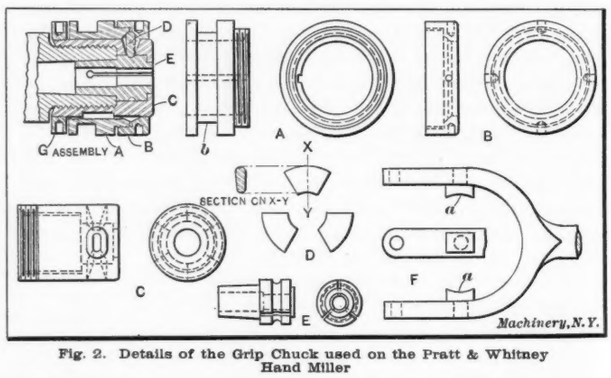


Fig. 2. Details of the Grip Chuck used on the Pratt & Whitney Hand Miller

not provided, it can easily be seen that the toggles would pass over the center to an angular position on the opposite side, when the chuck would again open. The cap *B*, while acting as a seat for the toggles, is also used for changing the diameter of the chuck. This is accomplished by screwing it up on the sliding sleeve *A*, thus forcing the toggles *D* downward and decreasing the diameter of the chuck.

This chuck answered the purpose very well and after a little practice a boy was able to cut off key-pins in one-third the time that was required to cut them in the capstan lathe. The parting tool for cutting off the key-pins was held in the milling machine vise, as was also the stop for gaging the length of the key-pins. G. H. GIBBS

Leicester, England.

A REVOLVING TURRET DRILL-HOLDER

The accompanying illustrations Figs. 1 and 2 show a four-hole turret drill-holder, which was used in a turret lathe for drilling the four holes *A*, and reaming the hole *B* in the casting shown to the left of the illustration Fig. 1. This cast-

ing was made from brass and was finished complete in the turret lathe. It was held in the chuck by the arms *C*. The half-hole *D* cast in it, acted as a driver on the dog *F*, for the drill-holder.

In operation, the shank *E* of the holder, Fig. 1, is held in the turret, and after the other machining on the casting has been done the spindle is stopped, the dog, or driver, *F* located in the half-hole *D* in the casting, and the spindle run backwards. The turret is then advanced, when the reamer *G* reams the hole *B*, and on further movement of the turret, the reamer shank G_1 is forced back into the holder against the tension of a spiral spring. The stripper plate, or rather the bushing carrier, *H*, then comes up against the face of the casting, and is forced back allowing the drills *I* to project, thus drilling the four holes *A* simultaneously. The bushing carrier *H* is forced outward by three spring-pins *J* and the dog *F*. The drill-holders *K* can be seen projecting from the top of the holder in the illustration.

A clearer idea can be obtained of the working mechanism of this tool by referring to Fig. 2. All the parts mentioned in Figs. 1 and 2 bear the same reference letters. The cross-sectional view shows this tool clearly, giving a good idea of its complicated mechanism. The reamer *G*, which reams the hole *B* in the casting, is screwed to the shank G_1 which is

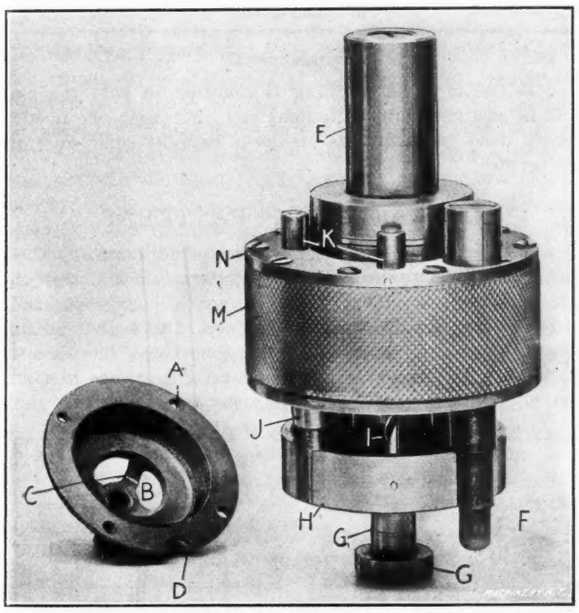


Fig. 1. Four-hole Turret Drill-holder and Work on which it was used

forced outward by the spiral spring G_2. G_1 also has a key G_3 inserted in it, which prevents it from turning in the body *E*. The stripper-plate *H*, or the guide for the drills *I* is cut out to fit around the dog *F*, and is also made a sliding fit on the body of the holder *E*. Connected to the body of the holder *E* by a key, is a spur gear *L*. This spur gear drives the four drill-holders, or spindles, *K* which have teeth cut in their peripheries meshing with the large gear. The drills *I* are screwed in the spindles *K*, and have a left-hand thread cut on them. The outer casing or body *M* of this holder is counterbored from the rear, and a cap *N* is screwed onto it as shown. The gears *L* and *K* work in this counterbored space. Sleeves are provided for the spring-pins *J* and dog *E*, so that springs may be inserted behind them, to force them out. Eight pins *O* are driven half into the hub of the knurled casing or body *M*, and half in the stripper *H*, to prevent the stripper *H* from rotating independent of the revolving parts of the holder. A nut *P* holds the stripper *H* to the body *E*, but allows it to turn with the revolving parts.

This holder is provided with ball bearings as shown, which are held in the retainer P_1. Two hardened steel washers *Q* are also provided. If left-hand drills had been used, it would not have been necessary to reverse the spindle of the machine. However, the man who paid the bill was so disgusted at the cost of such a complicated device, considering the simple work which it had to perform, that he dispensed with its services, and the writer arrived just in time to reclaim it from the scrap-heap.

Considering the simple drilling to be done, for which this tool was designed, it seems to be a very extravagant piece of work, as with a simple jig and a four-dollar-a-week boy to operate it, these castings could be finished at a smaller cost than would be possible by using this complicated device. The writer cannot imagine why the outer body *M* was knurled, un-

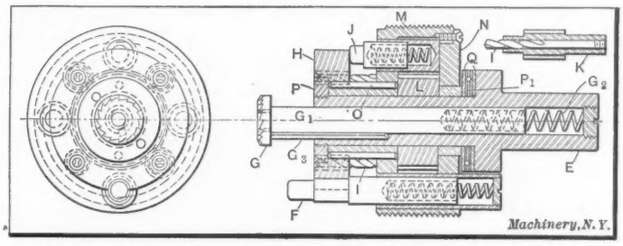


Fig. 2. End and Sectional Views of the Four-hole Turret Drill-holder, showing its Construction

less it was to make the customer think that he was getting something good for his money.

In conclusion the writer would state that he has found by long practical experience that the best way to manufacture is the simplest way no matter how much accuracy is required. This principle also applies to parts which are made by the use of dies in power or foot presses. Some manufacturers make a sub-press die for some insignificant piece, which could be made in an ordinary open die at perhaps one-tenth of the cost, considering the output.

CHARLES WESLOW

Buffalo, N. Y.

SPACING THE CUTTING EDGES OF REAMERS

In the November number of MACHINERY appeared an article by "H. M.," on spacing the cutting edges of reamers to prevent them from chattering, in which he suggests that reamers with 5, 7, 9 and 11 teeth give the best results, but he does not offer any reason why this should be the case. Without taking up the cause of reamers chattering, let us consider the effect of chattering in use. When a reamer with cutting edges spaced the same distance apart chatters, it forms "hills and valleys" the same distance apart. It can therefore easily be seen that the cutting edges, being the same distance apart as these "hills and valleys," will follow in the same chatter marks. Now on the other hand, if the reamer has an odd number of teeth, or an even number of teeth unevenly spaced, there is less chance that it will chatter. In the latter case

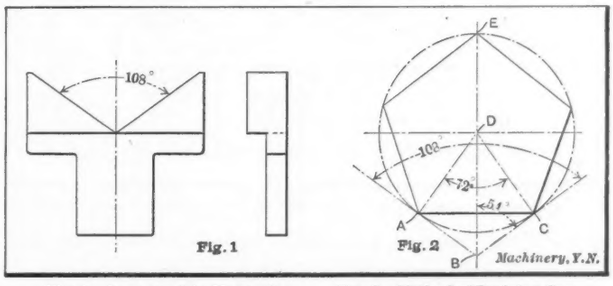


Fig. 1. Gage used in Measuring Reamers having Five Cutting Edges

Fig. 2. Method of Deriving Constant for Finding the Diameter of the Reamer

this is especially true because each tooth will only come in line with the previous mark when the reamer is in one position.

The best use which the writer has found for the reamers with odd number of teeth, is in reaming a split box or a hole which has grooves running its entire length. Reamers having five cutting edges have been used satisfactorily for this work.

In regard to the measuring of reamers having an odd number of cutting edges, the easiest and cheapest way to measure them, is to use a segment of a ring which has been bored out to the finished size of the reamer, and then measure from

the outside of the segment over the opposite teeth; deducting the thickness of the segment, will, of course, give the size of the reamer. If more than one size of reamer is to be made, a V-gage, shown in Fig. 1, can be made which will facilitate the measuring of reamers having an odd number of flutes. In using this gage for reamers having five flutes, the size of the reamer equals the micrometer reading divided by 1.118.

The method of obtaining this rule is as follows: Assume that the radius of a circle is 1 inch. Then for a reamer having five flutes, as shown in Fig 2, the distance *D-B* equals the radius, or the distance *D-C*, divided by the sine of 54 degrees, or $\frac{1}{0.80902}=1.236$. Then the distance *E-B*, or the micrometer reading $=1+1.236=2.236$. Now for a circle 1 inch in diameter, the distance $E\text{-}B=\frac{2.236}{2}=1.118$, which is the constant required.

Other gages could be made for reamers having an odd number of flutes, and the same method used for finding the constant, which would simplify the problem of obtaining the diameter. W. S. P.

CAM MILLING FIXTURE

The accompanying line drawings show the main parts of a motor cycle engine cam milling fixture. The cam to be machined is shown at the bottom of Fig. 2, and is a combination drop-forged gear and cam.

A base *A* and stand *B*, Fig. 1, are bolted to the milling machine table which remains stationary throughout the operations. On the base *A* there is a sliding housing *C* through which pass an arbor *D* and a shaft *E*. In this housing there is a gear *F* meshing with a corresponding pinion *G* on the lower shaft *E* with a ratio of two to one. Pinned to the large gear *F* is a master cam *H* on the arbor. On each end of this arbor *D* there are reduced sections over which the work (which is shown in broken lines and also in Fig. 2), is slipped and secured in place by tightening up the end nuts. On this arbor there are also steel templets *I* in alignment with tne master cam so that the rough cam and gear when placed chined. The cam blanks are fed up against the cutters by revolving shaft *E* through wheel *O*, two revolutions of this being necessary for a complete revolution of the cam blank.

It will be noticed that the cutters and master roller must of necessity be of the same diameter. Another point to be

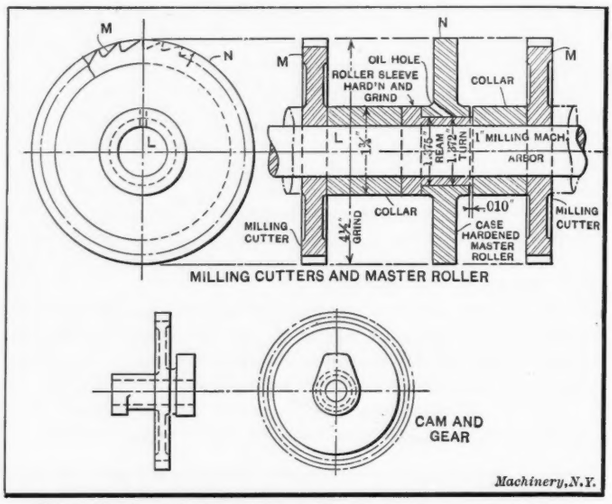


Fig. 2. Details of the Cam to be milled, and Arrangement of Cutters and Master Roller

noted is the fact that nothing is required to hold the cam blank in position against the templet *I* other than the friction between these two; this has proved to be quite sufficient from long service. V.

ALTERATION OF PATTERNS

The article in the December issue of MACHINERY by C. S. Bourne in regard to "Alteration of Patterns" is a step in the right direction. In many shops where a change is made during the erection of a machine, no record is made, and this leads to trouble in later machines. Sometimes the foreman will tell the patternmaker to make a certain change to a pattern, but the drawing-room is not notified. When at some

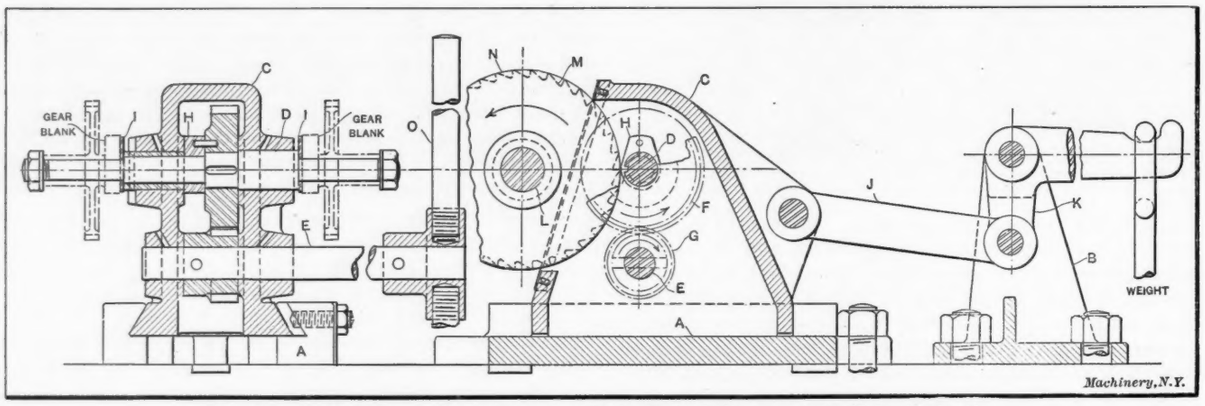


Fig. 1. Cam Milling Fixture ready for Operation, with the Master Roller in contact with the Master Cam

on the arbor may be readily trued up, adjusting so that the same amount of stock may be removed on all sides.

On the back of the housing *C* are ribs to which the link *J* is attached, the other end of the link being attached to the lower arm of a bell-crank *K*, this latter being pivoted on the stationary stand *C*, before mentioned. The outstanding arm of the bell-crank is notched to receive a weight. This weight, acting through the bell-crank tends to keep the housing *C* to its extreme left position.

The milling machine arbor *L* has on it two milling cutters *M* and a master roller *N* placed opposite, respectively, to the rough cam blanks and the master cam. This milling arbor with its master roller and cutters is shown more in detail in Fig. 2. The previously mentioned weight on the end of the bell-crank keeps the master cam up against the master roller, thereby giving the correct contour to the cams being ma-

future time the part is needed for repairs, the pattern is not like the drawing and the question is raised as to which is correct.

In one shop where the writer was employed, all changes were reported to the drawing-room and, if important, were made on the tracings and blueprints at once. If not important, or on a large piece, a record only was made on a card, for future reference. In case an order came in for a duplicate machine, the order first went to the drawing-room, and the card of that particular machine at once gave all particulars regarding changes.

This system worked satisfactorily to all concerned, as it tended to keep the record correct and relieved the shop of the responsibility. This was soon appreciated as it saved many a "call-down" for not sending a repair part the same as that shipped with the machine. BENJ. WORTH

State University of Iowa FEB 2 1911

MOUNTING BLUEPRINTS

The same trouble as that referred to by J. B. & Co., in the How and Why department of MACHINERY for December, has been experienced by the writer in mounting blueprints. Good results, however, have been obtained by using tin, galvanized iron or strawboard sheets. These sheets should be about one inch larger each way than the print, thus allowing a margin of half an inch. After applying common library paste to the tin or sheet, making certain that the paste is not lumpy, lay the blueprint in water and hang up to partially dry. When about as dry as a sponge that has had the water squeezed out of it, lay it on the metal and carefully smooth out the wrinkles by hand and then set aside to dry. The print will shrink slightly in drying, and will therefore be very smooth. Finally give one coat of white shellac, and in a few minutes it is ready for use.

This method of mounting was accidentally discovered one day when the writer did not have the time to thoroughly dry the blueprint before mounting. Previously considerable trouble had been experienced through wrinkled prints, but this method has entirely overcome that difficulty. E. H. R.

In the December number of MACHINERY, J. B. & Co. ask a question regarding the mounting of blueprints for shop use. Common strawboard is a good and cheap material for mounting prints. For prints 14 x 20 inches or smaller, use No. 20 (20 sheets 26 x 38 inches to the bundle), which is a scant ⅛ inch thick. Trim the print ½ inch larger all around than the cardboard, notch the corners of the print, and fold over and paste the ½ inch edges on the back of the card. Use stiff library paste rubbed onto the edges of the card with a flat stick or with the finger, and work the print down tight to the card with a putty knife having a smooth rounded edge. The stiff paste sets quickly, and holds the edges of the print, and there is no moisture to stretch the face of the print out of shape. This leaves the print held to the cardboard by the back edges only, the face or printed side simply lying close to the card. Prints so mounted answer all requirements for shop use. They are easy to mount, light to handle, stack nicely in racks, and look neat. When they get dirty or torn, run a knife under the face side, cut the print off, and paste on a new one. Do not shellac prints; they are not worth it. Do not make changes on prints unless for a hurry job, when there is not time to change the tracing and make a new print.

Niles, Cal. F. A. DEW

In the December number of MACHINERY, J. B. & Co. ask for a simple and efficient method of mounting blueprints. In reply to this the writer would say that he has found nothing more satisfactory for backing, than strawboard, or better still, pressboard which has a harder and smoother surface, to which the blueprint will more readily cling. This has a decided advantage over a metal backing where the prints are kept flat, one lying on top of the other, as there are no sharp corners or edges to mar the surface of the prints, when one is being withdrawn from the pile. Both sides of the pressboard may be used for mounting.

Another very convenient and successful method is to mount prints on ten- or twelve-ounce ducking. This is accomplished by first preparing the ducking by giving it a coat of glue sizing, such as is ordinarily used by paper hangers, and then allowing it to dry. The print is then mounted on this ducking, by using a good flour paste, or still better, prepared library cream paste. After the paste has been thoroughly dried the surface of the print may then be coated with white shellac. This has one advantage over pressboard, in that it will either lie flat or may be rolled without injury, for carrying or storing.

Changes on a shellaced blueprint may readily be made by rubbing the portions to be changed with a fine sandpaper, thus making a dull spot, which will readily take drafting ink. After the changes have been made, the print can again be coated with shellac.

A simpler and quicker method than that given above, is to make the prints directly on heavy blueprint cloth, which may be obtained from any manufacturers of blueprint paper. Prints made on this, after receiving two or three coats of shellac are quite stiff and serve very nicely as shop prints, especially where a board is provided to which they may be hung for display. P. F. LUETH

Everett, Wash.

MACHINING SPUR GEAR BLANKS

The plan followed by the Acme Machine Tool Co., Cincinnati, in turning change gear blanks, is to first bore and face one side of the blank in a screw machine, after which the blanks are held on the expanding stub mandrel shown in

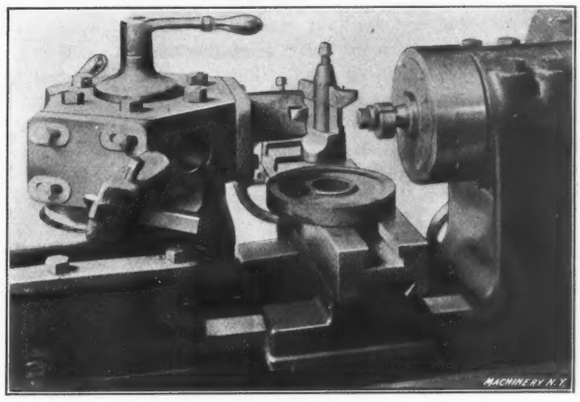


Fig. 1. View showing the Stub Mandrel used in holding the Gear Blanks for the Second Operation

Fig. 1. When held on this stub mandrel, a roughing and finish cut is taken from the other side with the two turning tools on the cross-slide shown in Fig. 2. The periphery of

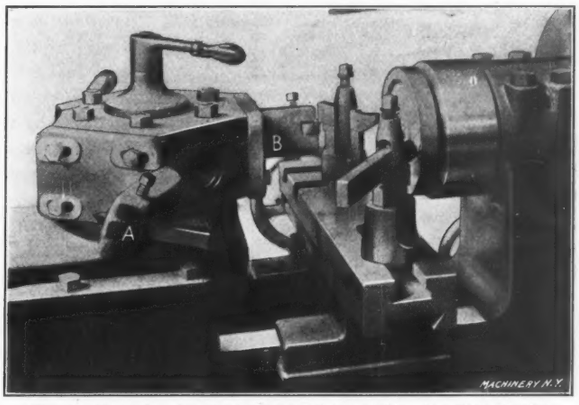


Fig. 2. View showing the Tools used in Finishing the Gear Blanks

the blanks is also roughed and finished in this operation to the exact diameter by the two turret tools, *A* and *B*. For turning the periphery it is only necessary to draw the cross-slide tools back a little further than the cutting position in order to let the turret tools pass. E. V.

THE CARE OF OIL DRIP CUPS

A correspondent in the January number of MACHINERY calls attention to the fact that oil drip cups work loose, due to vibration, and offers a suggestion for holding the drip cups in place so as to prevent the cup from falling to the floor.

The best method in the writer's mind is to have the thread on the bolt of the hanger a tight fit in the tapped hole in the hub of the drip cup, and then to screw the cup up "good and tight," and *let it stay there*. When the drip cup requires to be emptied, a large-sized hand-pump is used. One pull of the plunger empties the cup, and one push empties the contents of the pump into a pail. By this method all chances of getting a free oil bath, or of the cup dropping, are eliminated. It may not be amiss to say that the best time for emptying drip cups is during the noon hour, or at some other time when the work is discontinued, so that the man doing this work will not get in the way of the machine operators, and time will not be wasted by stopping the machine in order to facilitate the task.

Waterbury Mass. CHARLES DOESCHER

BORING-DIMENSIONS FOR LARGE THREADED HOLES

If a machinist has a piece to bore and thread, he often has difficulty in obtaining the allowance to leave for the threads, in boring the hole. To get accurate results, he would, of course, have to consult a table, which may not be within convenient reach, in which case he may have to refer the matter to the drafting-room.

In a certain shop the writer noticed that one particular man was often applied to for information of this kind. He would quickly give the correct amount to allow for the thread, without hesitation and without consulting any tables or handbooks. It did not seem clear what method he used, but, in fact, his method was so simple that it is a wonder that it is not more generally applied. He carried in his head the amount that would have to be allowed for a thread of 1-inch pitch, and he divided this figure by the number of threads per inch in each particular case. In a case, for example, where 10 threads per inch, 4-inch diameter, were to be cut, the amount to be allowed would be $\frac{1.299}{10} = 0.130$ inch, and the hole would be bored to $4 - 0.130 = 3.870$ inches diameter. The advantage of the method is that only one figure need be carried in the head. It is easily remembered, and there is no need to look up tables which are generally out of the way when required. The constant 1.299 used above is the double depth, in inches, of a United States standard thread of 1 pitch. In fact, the man who was using this method had not the slightest idea of what the figure 1.299 represented, but he knew that by dividing it by the number of threads per inch, he obtained the required result. The constants for the other standard forms of thread are as follows:

Whitworth	1.2806
Sharp V	1.732
French and International standard	1.299
Acme	1.000

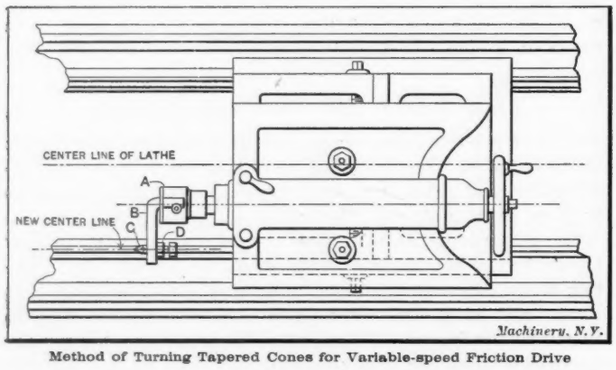
With the French standard the constant is multiplied by the pitch in millimeters and the result obtained will then be expressed in millimeters. If required in the English measure, divide the result obtained by 25.4.

Coventry, England — T. BARTON

A DIFFICULT TAPER-TURNING JOB

The writer at one time had occasion to turn up two cast-iron cones for a variable-speed friction drive, and not having a lathe with a taper-turning attachment, nor being able to set the tailstock over far enough to obtain the desired taper, he adopted the following scheme.

A drill chuck, *A*, was inserted, as shown, in the tailstock spindle of the lathe, and clamped in the chuck was a bar bent at right angles and forged round on the shank, so that it could



Method of Turning Tapered Cones for Variable-speed Friction Drive

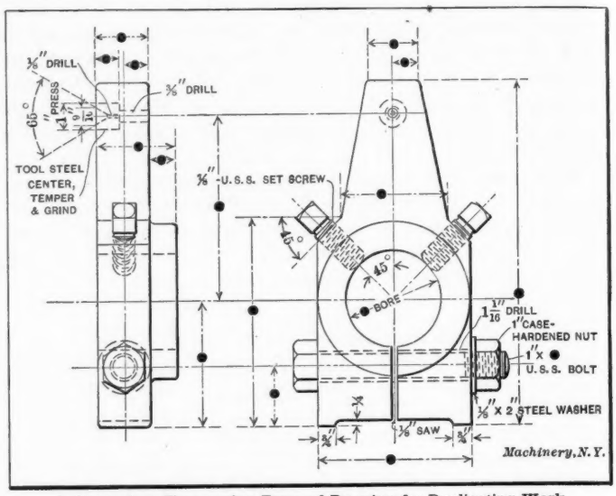
be held securely. A cone-pointed screw, *C*, was screwed into the projecting leg and was checked by a nut, *D*. The point of this screw was casehardened and was set off from the center of the lathe a distance sufficient to give the desired taper.

To prevent the bar *B* from turning in the chuck a block, not shown in the illustration, was placed under it and on top of the ways of the lathe, and a C-clamp used to hold the bar *B* down on this block.

Dallas, Texas. — SIDNEY HETHERINGTON

TIME-SAVING METHOD FOR DUPLICATING WORK

At the present time there is a tendency in manufacturing to standardize drawings. The illustration shows a drawing of a center for turning crankshafts of large sizes. The design is not a new one, as I have seen it in several different factories, but it illustrates a convenient time-saving method for duplicating work of this or various kinds. It saves a great deal



A Convenient Time-saving Form of Drawing for Duplicating Work

of time where many drawings of articles of practically the same design are needed, but with different dimensions. This idea involves only the time for making one drawing and tracing, and several blueprints may be printed from it, and the required dimensions inked in, in the blank spaces shown. Blank spaces at the lower right-hand corner should also be provided for a change of title. — JIG AND TOOL DESIGNER

CARE OF LATHE CHUCKS

In the December number of MACHINERY John Homewood draws attention to the fact that three-jawed universal chucks are abused and sprung out of true, by putting a pipe on the chuck wrench, when tightening the jaws on the work.

Inasmuch as there are other abuses that this handy and useful tool is often put to, it seems that mention of them should be made through the columns of MACHINERY, together with a few suggestions regarding the elimination of the troubles. While lathe chuck abuses are usually due to carelessness on the one hand, they are more often the direct result of employing cheap and inexperienced help.

The most common abuse to which a lathe chuck is put, is that of screwing it up against the shoulder of the lathe spindle with a bang, and then because it won't come off readily, a long bar of steel or iron is placed between the jaws to loosen it, thereby springing the jaws and injuring the scroll. All chucks should be screwed lightly up against the lathe spindle. In order to remove them without springing the jaws, a hole should be drilled in the neck of the chuck faceplate, so that the chuck can be loosened by a spanner wrench.

Forcing the chuck on the spindle regardless of chips or grit that may be in the threads, is another abuse that does not tend toward the welfare of the chuck or lathe spindle. Chucking rough bar stock that is considerably out of round, forgings, castings, etc., in a four-jawed universal chuck is another common abuse that should not be tolerated, for the reason that the jaws and scroll are either sprung or bruised. Using a piece of sheet steel or brass under one or two jaws, in order to make an eccentric pin or punch from a piece of stub wire, is still another abuse that does harm to the chuck. Cutting off work with a parting tool that is set under the center, often causes the work to spring up and ride on the tool, when it is almost cut off, particularly when the spindle is a trifle loose. This also causes the chuck to spring out of true. Lathe chucks should be taken apart when necessary and thoroughly cleaned and oiled, in order to prolong their life.

Waterbury, Conn. — CHARLES DOESCHER

State University of Iowa FEB 2 1911

SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

A HANDLE FOR SMALL FILES

The accompanying illustration shows a very convenient handle for use on small files. It is made from two pieces of stiff leather, ⅛ or 3/16 inch thick, which are held together by small

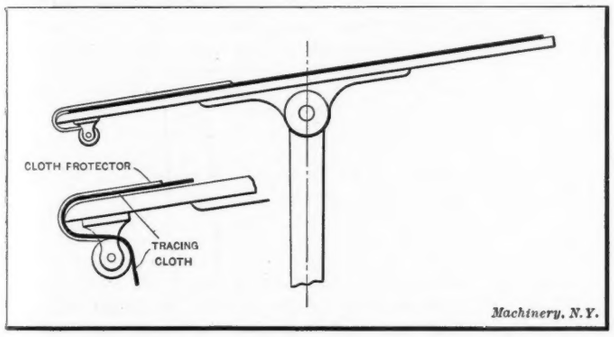
brass nails or screws. The corners of the handle are rounded off, making it convenient to hold in the hand. The tail of the file is slipped in between the two pieces of leather, thus holding it effectively.

East Syracuse, N. Y. C. W. SHELLY

PROTECTING TRACINGS AND DRAWINGS

A very convenient means of protecting a drawing or tracing from being soiled by constant leaning on it is shown in the accompanying illustration.

It is in every way superior to using various pieces of paper, as is usually done. As shown, this device consists simply of an ordinary spring-roller curtain fastened underneath the

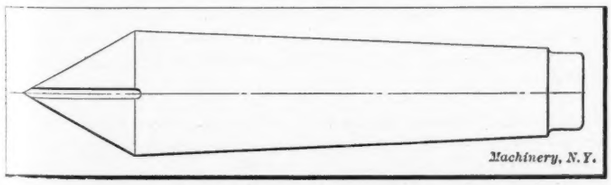


drawing-board, in such a manner as to permit the tracing to hang over it when occasion demands. The curtain material can be of curtain linen, paper or tracing cloth; the latter is preferable, however, owing to its transparency, and also to the fact that it can be easily cleaned when soiled.

WINAMAC

PREVENTING DEAD CENTERS FROM BURNING

The accompanying illustration shows a method of preventing dead centers from burning when turning fast revolving stock or where excessive pressure is applied, as, for instance, in taking a heavy cut on large stock. The center shown has a groove ⅛ inch wide by ⅛ inch deep cut to the extreme point and the sharp corner filed off, so that it will not ream out the center in the work. It is obvious that as the work revolves



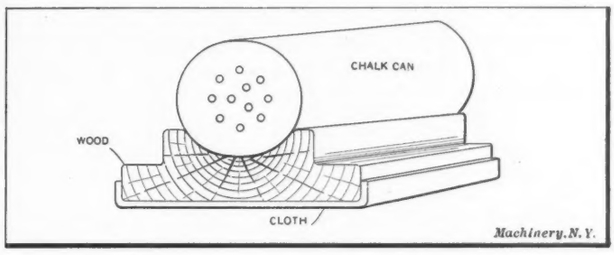
the turning tool has a tendency to raise it so that it pulls up against the bottom of the center, thus preventing the dead center from reaming the center in the work. For small work it is sometimes advisable to reduce the depth and width of the slot, depending on the diameter of the work. A good lubricant is prepared by mixing together, in equal proportions, beef tallow and graphite. This should be well mixed, and if applied in the groove of the dead center will prevent it from burning.

L. J. GETZ

Salem, Ohio.

A CHALK PAD FOR DRAFTSMEN

As I found it inconvenient to use a chalk can and rag for chalking tracings, I made a little device which is neat in appearance, and inexpensive for any draftsman to make. It consists of a wooden block shaped as shown in the accompanying illustration to hold a chalk can, and has a piece of cloth glued



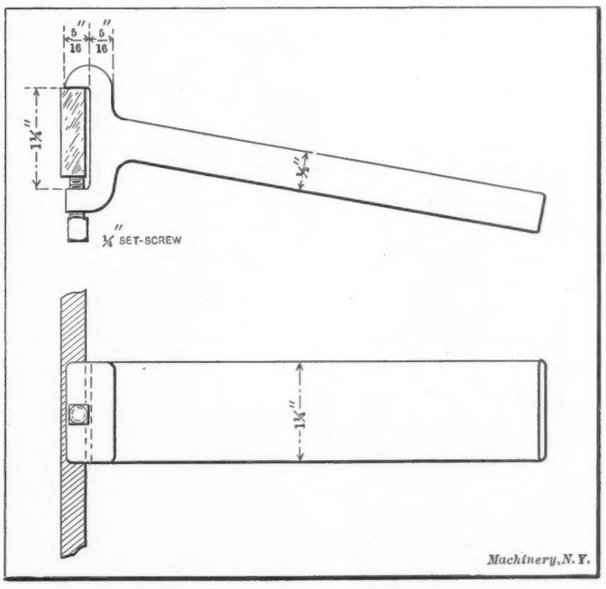
to it, similar to that used on pool and billiard tables. This makes a very convenient chalking device.

Toledo, Ohio. GEORGE J. NEY

A TOOL FOR FACING CAST GEARS

More or less trouble is experienced in facing off the sides of cast gears with ordinary turning tools, because of the chatter as the tool jumps from one tooth to the next. The tool shown in the accompanying illustration, however, was designed especially to overcome this tendency, and has been found to give satisfaction.

The tool consists of two parts, a piece of broken file about 3 inches long and a wrought-iron or steel holder made to fit



in the regular toolpost of the lathe. The holder is made in such a way as to hold the piece of file vertically against the side of the gear as it revolves on the lathe centers, thus grinding or filing off to the proper finish. The broad bearing surface presented to the work effectually prevents all jumping and chattering.

C. A. ALLEN

Linwood, Mass.

* * *

By using tantalum lamps for car lighting the Chicago Railway Co., it is stated, finds that it can save about $18 a year per car. A thousand cars have been equipped with these lamps already, and when all the cars of the company are equipped this way, a saving of $35,000 a year will be accomplished.

HOW AND WHY

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published.

UNUSUAL FORMS OF GEARING

J. W. M.—What is the practical value to the engineer of the logarithmic sector gear; the lobed wheels formed from logarithmic spirals and ellipses; and the skew gear formed by rolling hyperboloids of revolution? Where are these gears used and how are they manufactured?

A.—The question is submitted to the readers.

TINNING CAST-IRON CROSSHEAD SLIPPERS

M. H. W.—Can any of the readers give a good method of tinning cast-iron crosshead slippers, so that the babbitt will hold while being planed? I do not mean a slow process by which a man spends considerable time on one, over a small fire; but some quick method of tinning a number at once. A good proportion of these slippers are old ones in the repair shop for rebabbiting, and are greasy.

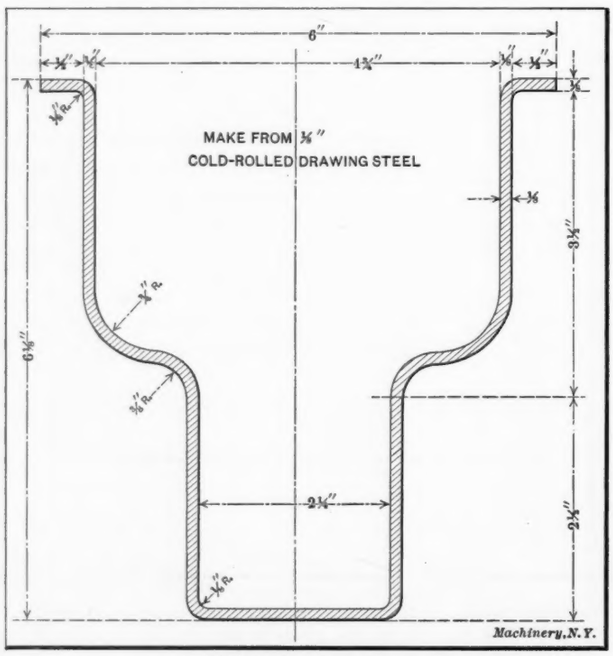
RESTORING OVER-EXPOSED BLUEPRINTS

Draftsman.—How can over-exposed blueprints be saved? I understand that by the use of certain chemicals a blueprint, totally spoiled by being over-exposed, can be restored.

A.—An over-exposed blueprint can be restored to an acceptable tone by a bath consisting of a teaspoonful of crystals of potassium bichromate in one-half gallon of water. The blueprint is first washed in the usual manner, and then immersed for half a minute—or less—in the bichromate solution. After having been treated, it is washed in clear water and hung up to dry.

DRAWING A COLD-ROLLED STEEL SHELL

C. H. R.—I would like to ask the readers of MACHINERY how they would draw up a steel shell like the sketch; how many operations would be required; what are the sizes of the



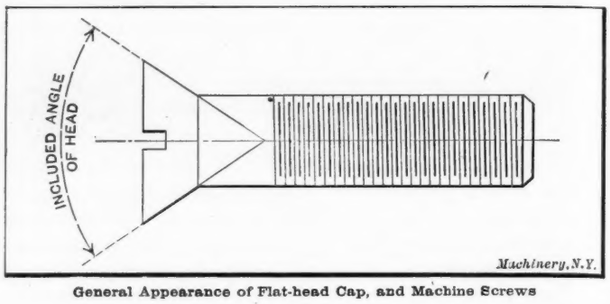
Steel Shell to be drawn

dies and how should the work proceed? The writer has estimated that twelve operations would be required. These include turning at right angles and the trimming of the flange after drawing. Of course the walls of the 2¼ inch diameter part will be drawn slightly thinner than ⅛ inch, but this is permissible.

FLAT-HEAD CAP AND MACHINE SCREWS

C. A.—Is there any accepted standard for the included angle of the heads of flat head cap screws? What is the difference, if any, between a flat head machine screw and a flat head cap screw?

A.—As regards general appearance, there is no difference between the flat head machine screw and the flat head cap screw. They both have the appearance indicated in the accompanying engraving. There is, however, a distinction made between these two classes of screws in the screw manufacturing field. The cap screws are made in sizes varying by 1/16 inch, up to 1 or 1¼ inch diameter, while the flat head machine screws are made to the regular standard machine screw dimensions. The American Society of Mechanical Engineers has recommended an included angle of 82 degrees for the head of flat head machine screws. For flat head cap screws,



General Appearance of Flat-head Cap, and Machine Screws

no standard has ever been officially recommended or recognized, but 70 degrees included angle has been assumed by many manufacturers as being a standard established by usage. A great deal of confusion, however, seems to exist in regard to the angle for both cap and machine screws. In order to place on record the present conditions in this respect, information has been gathered from a number of screw manufacturers; it will be seen that there is as yet no thoroughly accepted standard either as regards machine or cap screws.

The Atlas Bolt & Screw Co., Cleveland, Ohio, states that there is little call for flat head cap screws or machine screws made with the 82-degree (the A. S. M. E. standard) angle. The standard used by this company is about 84 degrees included angle for both cap screws and machine screws.

The Chicago Nut Co., Chicago, Ill., in making machine screws, has adhered to the 82-degree angle recommended by the A. S. M. E. ever since the society's report was issued.

The Cleveland Automatic Machine Co., Cleveland, Ohio, states that in filling orders for tools for cap screws and machine screws it has been found that the angle called for is usually the 82-degree or the A. S. M. E. standard angle.

The Columbia Screw Co., Pullman, Ill., has made screws with the 82-degree included angle for the last twenty years, and does not make use of any other angle.

The Critchley Machine Screw Co., Worcester, Mass., makes the included angle of flat head cap screws about 80 degrees.

The Hartford Machine Screw Co., Hartford, Conn., makes the included angle of flat head cap screws 70 degrees, and considers this to be the standard angle.

The National-Acme Mfg. Co., Cleveland, Ohio, has for some time past made all regular flat head cap screws with an 82-degree included angle.

The National Sewing Machine Co., Belvidere, Ill., has always used a 76-degree included angle for flat head cap screws. This company has had but one call for screws with an 82-degree angle in the last year.

The Philadelphia Machine Screw Works, Philadelphia, Pa., uses the 82-degree A. S. M. E. standard angle only when requested by customers; otherwise cap screws are made with a 90 degree included angle.

The Reading Screw Co., Norristown, Pa., uses the 82-degree angle for all flat head countersunk machine screws.

The Reed & Curtis Machine Screw Co., Worcester, Mass., does not make screws to any extent according to the A. S. M. E. standard angle, nor does this company make regular machine screws. For cap screws a 70-degree included angle is used.

The Screw Machine Products Corporation, Providence, R. I., states that there is but little demand for screws with the 82-degree angle, and that, in fact, but one order has been made to specifications calling for this angle.

The Worcester Machine Screw Co., Worcester, Mass., uses a 76-degree angle for flat head screws. The call for screws with the A. S. M. E. standard angle has been very limited.

As will be seen from the foregoing it is hardly correct as yet to speak of an angle as being standard, as different screw manufacturers use different angles. There seems to be a tendency, however, to adopt the 82-degree angle for flat head machine screws, but not for the flat head cap screws.

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"INS AND OUTS OF GEAR HOBBING"—A COMMENT

By PERCY C. DAY*

Gear-men are indebted to Mr. Flanders for so much useful and impartial information on their pet subject, that they will be inclined to forgive him for his latest contribution. But those who are interested in the hobbing process can hardly be expected to let it go at that. Those who read Mr. Flanders' article in the January number of MACHINERY (engineering edition) entitled "Ins and Outs of Gear Hobbing," might reasonably expect to find some illuminating truths about a much abused process. What they will find is a record of some experiments which have been carried out under peculiarly unfavorable conditions.

In the first place, the blank appears to have been chosen for a gear of 21 teeth with standard addendum and 14½-degrees pressure angle. So much information has emanated from Springfield, Vt., in regard to the greater suitability of stub-teeth and high-pressure angles for all generated gears, that it is hard to understand why an expert from that neighborhood should have chosen to conduct his experiments on other lines. It should further be noted that Mr. Flanders, in a paper which he read before the American Society of Mechanical Engineers in December, 1908, (see MACHINERY, January, 1909, engineering edition) clearly demonstrated that the smallest number of teeth in an interchangeable series of standard form is 32. In spite of this he chooses for his test an uncorrected hob for a standard gear of 21 teeth.

The experiments are described as having been carried out on a hobbing machine of the highest grade, with a hob which represented the best of American practice. The adjustment of the machine was, however, admittedly slack at all points. This alone is sufficient to account for the results obtained. How an investigation of this character could be undertaken, and such an important detail as the adjustment of the machine overlooked, is difficult of explanation.

The results obtained on a loosely-adjusted hobbing machine are compared with the work done on a Fellows gear shaper under similar conditions, to the detriment of the former. This kind of comparison can only be misleading, because, when once a machine is out of adjustment, the quality of the work turned out is merely a question of how much slackness exists between the various parts. Nothing is said with regard to the hobbing machine when properly adjusted; in fact, the machine used for the experiments appears to have remained out of adjustment during the whole investigation.

Frankly speaking, the writer is interested in the hobbing process, particularly in reference to helical gearing. In several years' experience of gear hobbing on a large scale he has never seen teeth which bore the faintest resemblance to the corrugated outlines exhibited in Figs. 4 and 5, of the article referred to.

Regarding the effect of centering the hob teeth, there is much useful information to be gathered from the article, particularly if reference is made to the article on a similar subject previously referred to. The practical experiments are, however, quite inconclusive, and the results obtained appear to have been of an arbitrary nature, due to the want of adjustment in the machine used. The suggestion that the discrepancies may be due to inaccuracies in the hob itself, produced by distortion in hardening, while quite in accordance with general experience, cannot very well be proved in this particular case. Every gear cutting process, whether generating or otherwise, has its own peculiar disadvantages, but the hobbing process is not any more handicapped than others in this respect. Mr. Flanders points out as faults in principle some details which are really only faults of design.

The reason why imported hobs are reputed to be superior to the domestic article is probably to be found in the fact that foreign hob makers have equipment suitable for accurately gashing, relieving and grinding their hobs. Straight-fluted hobs are rarely used abroad, and the teeth are almost invariably gashed and relieved on lathes specially designed for the purpose. The writer does not know of a single American firm who manufactures a complete relieving lathe, although one or two supply relieving attachments for ordinary tool lathes. Those who require to manufacture accurate hobs are obliged to import the necessary equipment from Germany. This little fact alone is sufficient to account for a good deal of the hobbing troubles which seem to be experienced here.

There does not seem to be any reason why the hobbing machine should be at a serious disadvantage as compared with other generating machines. Is it not true that all generating machines require the preservation of a definite relationship between the motion of the cutter and of the blank to be cut? In the hobbing machine, when used for cutting a straight spur gear, there is undoubtedly some restriction in the size of the gears, shafts and bearings which can be used to transmit motion to the hob on its turntable. As a set-off against this, the motions in the hobbing machine are all continuous rotations in one direction; there is no reversing of rams or intermittent division of the blanks.

The amount of overhang of the hob arbor from the face of the vertical slide is a matter of design only. It is true that machines are built with excessive overhang, resulting in loss of rigidity, which produces poor work; but if the makers of hobbing machines would cease to try to cut small pinions on machines designed for work of a large diameter, this trouble would disappear. Hobbing is the only strictly generating process which is adaptable for large work. With all reciprocating systems, the difficulties encountered when starting and stopping heavy blanks and work tables, between strokes of a reciprocating tool, limit the range of successful application. It is probably for this reason that gear wheels of more than four feet in diameter are rarely generated on any but hobbing machines.

A large hobbing machine offers fewer difficulties to the designer than a small one. The shafts, gears and bearings become less restricted in proportion to the rest of the machine, and accurate work can be turned out without difficulty. It would therefore appear that the future of the hobbing machine lies rather with heavy than with light work. When used for the production of helical gears of constant spiral angle, the hobbing process offers peculiar advantages over all others. Helical gears are being regularly hobbed in England up to 14 feet in diameter, 40-inch face and 4½-inch pitch. Is there any other generating process which could successfully tackle work of these dimensions?

* * *

ANNUAL MEETING OF THE SOCIETY OF AUTOMOBILE ENGINEERS

The annual meeting of the Society of Automobile Engineers was held in the Assembly Hall of the Automobile Club of America, New York City, January 11 and 12. More than 300 members from all parts of the country attended the meeting. The total number of members of the society at the time of the meeting was about 600. The chief work of the society is the standardization of the technical and constructive work pertaining to the domestic motor car field. Papers were read at the meeting by Joseph Schaeffers, "Electro Steel"; by E. K. Rowland, "Leaf Springs"; by E. P. Batzell, "Novelties in Valve Systems"; by H. N. Anderson, "Hot Rolled Gears"; by F. H. Floyd, "Commercial Gasoline and the Impurities that are Being Encountered"; by G. N. Jeppson, "Development of the Grinding Wheel"; by John C. Spence, "Methods of Grinding"; by Charles E. Duryea, "'Frictionless' Friction Drive"; by N. B. Pope, "The Fire Protection Question"; by C. S. Ricker, "Automobile Contest Timing and Coaching"; by E. A. Myers, "Advantages of Long-Stroke Motors"; by A. J. Slade, "Foolproofing the Commercial Car Mechanism and Its Control"; by R. C. Lanphier, "The Ampere-hour Meter for Electric Vehicles." The paper by L. R. Evans and R. P. Lay on "The Test of a 20-horsepower Franklin Air-cooled Motor, which was postponed from the last meeting of the society, was also concluded. On Wednesday, January 11, the society had its annual dinner, followed by an entertainment arranged by the local committee.

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NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

Comprising the description and illustration of new designs and improvements in American metal-working machinery and tools, published without expense to the manufacturer, and forming the most complete record of new tool developments for the previous month

CINCINNATI BORING MILLS

The Cincinnati Planer Co., of Cincinnati, Ohio, is now manufacturing the boring mill illustrated in Fig. 1. This machine has a normal capacity of 10 feet which can be increased to approximately 16 feet, by shifting the housings along the extension base. This design is also built without the extension base in the 10-foot size. The capacity of both machines for height is 5 feet 6 inches.

The drive is either by belt to a single constant-speed pulley at the rear, or a motor may be employed, as shown in Fig. 2. Power is transmitted to the table through a speed box, which connects with a horizontal shaft transmitting the motion through bevel gears to a driving pinion, the latter meshing with an internal gear on the table. Fig. 4 shows a view of the base with the table removed, while Fig. 5 shows the under side of the table and its large internal gear. This gear is located near the periphery, so that a good driving torque is obtained, which is necessary when turning large diameters. By the use of an internal gear drive, a comparatively large tooth contact between the driving and driven gears is obtained, which gives a smooth and steady motion. With the internal drive, the gears are also protected from dirt and chips by the table. The speed box is mounted between the housings, as shown in Fig. 2, the machine being entirely self-contained, and a minimum of floor space being required. When a constant-speed motor is used, the speed box is arranged so that nine speed changes are obtained, giving the table a ratio of 1 to 36. When driving with a 2 to 1 variable-speed motor, a ratio of 1 to 18 is obtained which is doubled by the speed variations of the motor. The levers, by means of which the speed changes are effected, are provided with an interlocking device so that no two speeds can be engaged at one time. A speed plate is mounted near these handles showing the revolutions of the table, and also the surface speed for a given diameter. When a motor drive is employed, a twenty horsepower motor is required.

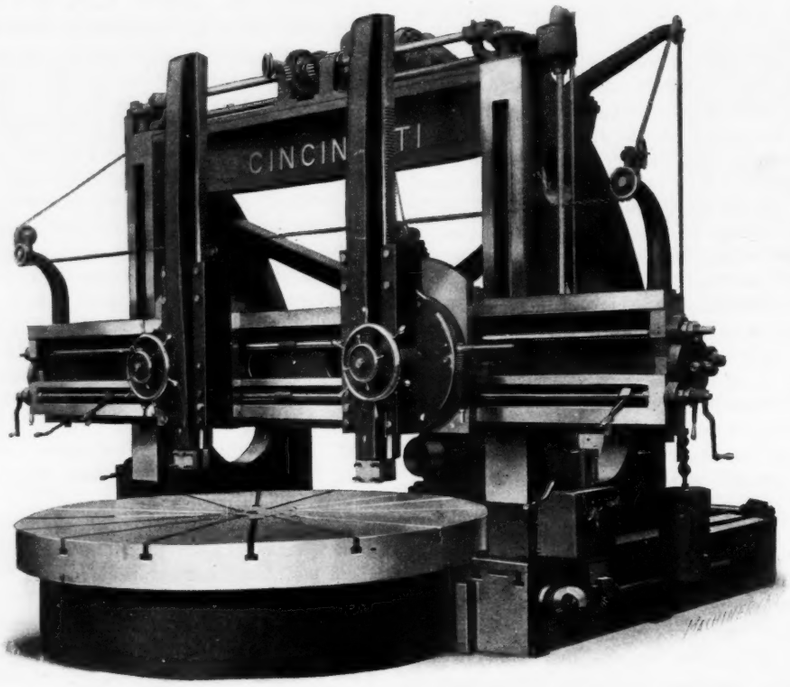

Fig. 1. Cincinnati 10- and 16-foot Extension Boring Mill

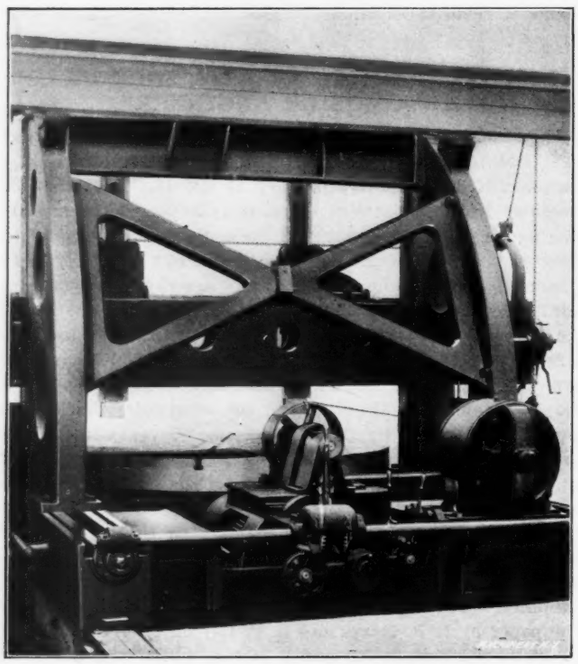

Fig. 2. Rear View showing Drive and Speed Box

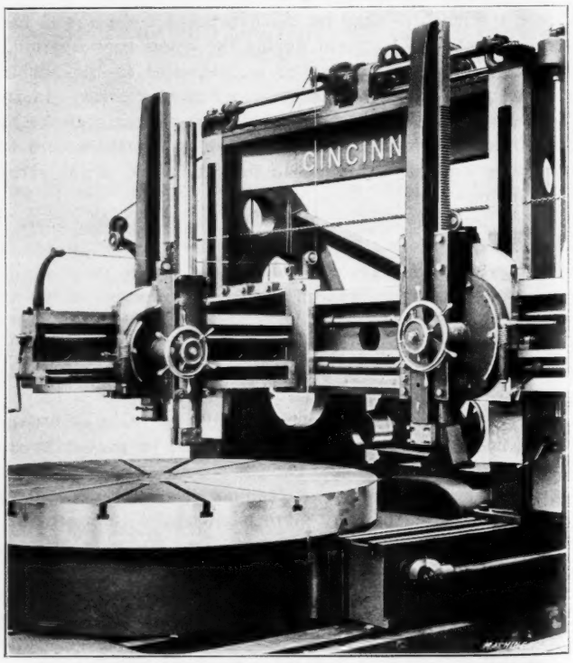

Fig. 3. Extension Arm used when the Housings are moved back

The feed changes on this machine are obtained through

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feed boxes, located on the sides of the housings. A separate feed box is attached to each housing near the base, as shown in Fig. 1, thus giving an independent feed for each head in all directions. Power for feeding is taken from the vertical driving pinion shaft which is connected to an intermediate shaft through spur gears, as shown in Fig. 4. This intermediate shaft drives, through spiral gears, a horizontal shaft that extends across the bed and transmits the movement

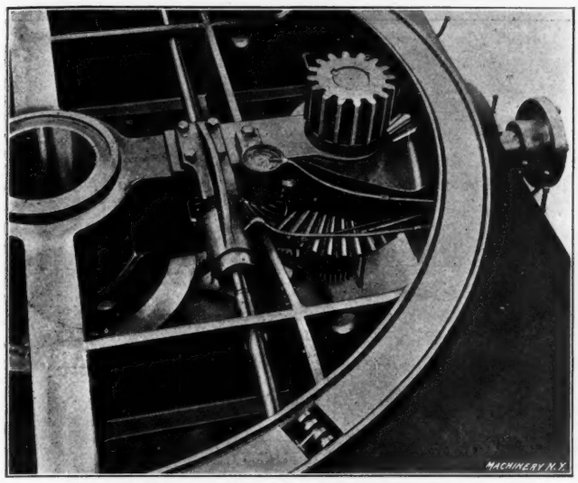

Fig. 4. Drive for Table and Feed Boxes

through bevel gears, to shafts *A*, Fig. 8, mounted at the sides of the base. Shafts *A*, in turn, connect with the feed boxes through bevel gears, as the illustration shows. These feed boxes are so located on the housings that the feed-controlling levers are convenient to the operator. Eight different feeds are available, ranging from 1/32 inch to 1 inch per revolution, and the changes are effected by the small pilot wheels or handles *B* and *C*. By means of handle *B* which operates a tumbler gear, four changes are obtained, and this number is doubled

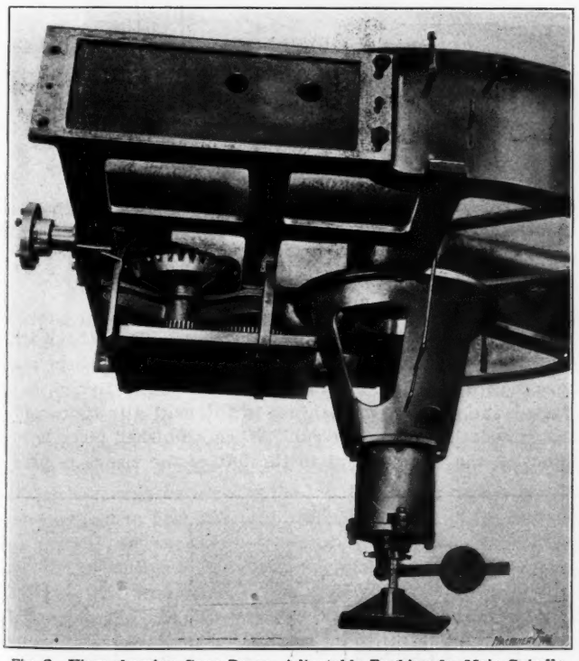

Fig. 6. View showing Cone Brace, Adjustable Bushing for Main Spindle Bearing, and Automatic Adjustable Step Bearing

by handle *C* which engages a clutch connecting the high or low speeds. A rapid power traverse is provided for moving the heads in any direction to eliminate any unnecessary work in the operation of the machine. These movements may be controlled from the cross-rail or feed boxes, there being four handles for this purpose. Two of these handles are seen projecting from beneath the cross-rail near the ends, and the other two are mounted on the feed boxes. These handles engage or disengage both the power traverse and feed, the operator using the one that is most convenient.

The bed of this machine is of box form throughout, and it has a depth of 21 inches. All parts are thoroughly ribbed and braced, and as the entire mechanism of the mill is supported on the bed, no foundation, except that for the base, is required. The table of this mill is 10 feet in diameter, 10 inches deep on the outside, and it has sixteen deep ribs, ra-

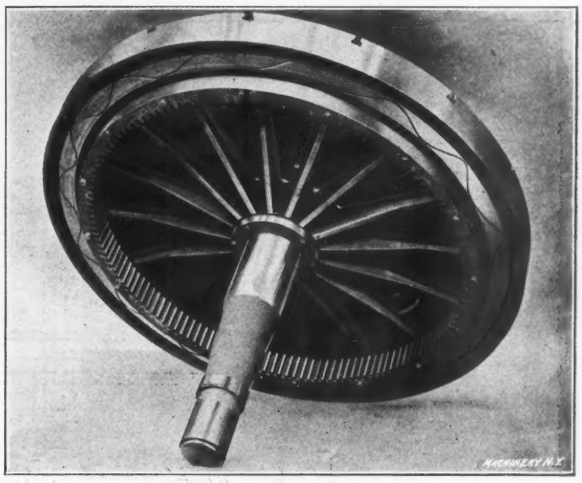

Fig. 5. Table and Spindle

diating from the center to the rim, as shown in Fig. 5, which insure rigidity. Three pockets are cored in the bed to receive automatic oiling devices for lubricating the table and the track. These pockets, one of which is shown in Fig. 4, are filled from the outside and are so arranged that the operator can see the height of the oil in them, thus insuring a proper amount of lubrication. The pockets can be drained and cleaned by inverting the inlet pipe.

The table spindle runs in an oil-filled step bearing, shown

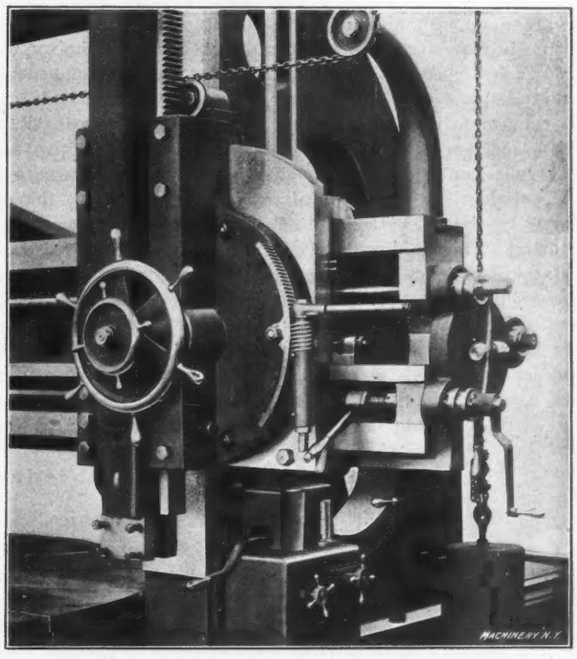

Fig. 7. Detail View showing Head and Controlling Levers for Feed and Rapid Traverse

in detail in Fig. 6. The adjustment for the table is made underneath and when the machine is first set on its foundation, it is aligned by means of this adjustment. After the aligning operation, the weight of the table is properly distributed between the rim and step bearings. The table is allowed to rest permanently on its rim bearing instead of raising it for comparatively high speeds, so that all chance of straining the spindle, especially when machining a heavy

and irregularly shaped piece, is eliminated. It has been found that the weight on the track is comparatively light, the pressure, when turning a piece weighing 5000 pounds, not exceeding 14 pounds per square inch of bearing surface.

The housings are of box form and have broad faces and wide bases; they are tied at the top by a deep three-ribbed arch, and in the back by an X-brace, as shown in Fig. 2. The housing bases are of box form and are secured to the bed by

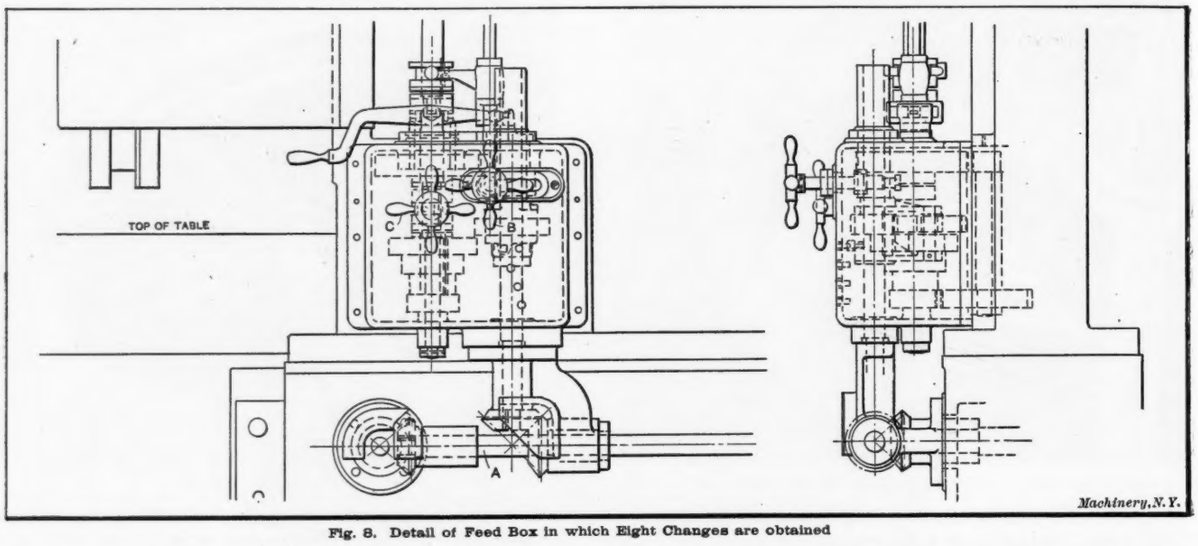

Fig. 8. Detail of Feed Box in which Eight Changes are obtained

six bolts and two dowel pins. When the housings need to be adjusted on the extension bases, a power traverse is employed, the power being taken from the speed box at the rear which drives a cross-shaft that, in turn, connects with the traversing screws.

The special extension arm that is used when the housings are set back for turning work of large diameter, is shown in place in Fig. 3. This arm is of massive construction and it is provided with an auxiliary swiveling head and a bar 6 inches in diameter, having a stroke of 48 inches. The vertical feed is by hand or power, and the bar has an independent counterbalance. This extension is so arranged that it can be conveniently removed at any time. The cross-rail, which has a depth of 30 inches, has a deep arch on the back so that any deflection due to the weight of the heads or pressure of the cut, is reduced to a minimum. It is secured to the uprights by clamps, both on the outside and inside edges of the housing. The guiding surfaces for the heads of this machine are both on the lower part of the cross-rail, to reduce the cramping or twisting action when the tool bars are extended some distance below the rail. The construction of the head is clearly shown in the enlarged view, Fig. 7. The saddles have three taper gibs that are adjustable for wear, and a sensitive adjustment for each saddle is provided. The tool bars are made from steel castings of large box section, and they have a travel of 48 inches. Each bar is independently counterweighted, and it has a rapid traverse by hand through a rack-and-pinion movement.

All the shafts used in this machine are of high carbon steel and accurately ground. The bearings are all bushed with bronze and have large oil chambers. The oil pipes leading to the main bearings all radiate from a central point, which adds to the convenience. The bevel gears are all accurately planed, and all sliding surfaces, such as those on the rail, housing faces, tool bars, etc., are carefully scraped to accurate surface-plates. The alignment of all parts is insured by special equipment.

BERGSTROM EXPANSION MANDREL

The Roren Drop Forging Co., Inc., 258 Broadway, New York, has placed on the market the expanding lathe and grinding mandrel, illustrated in Fig. 1. This mandrel, which is a Norwegian product, is composed of three pieces: the main mandrel, a sleeve and a nut. The sleeve is slotted as the engravings show, to give the necessary expansion, and the main mandrel over which it fits is tapering and has, in addition, four cam surfaces of spiral form. These cams or spirals are shown on a somewhat exaggerated scale in the sectional end view of Fig. 2. With this construction, any tendency of the sleeve to rotate with relation to the main mandrel, when a heavy cut is being taken, will cause it to be expanded more tightly against the work by the spiral cam surface; in other words, the work is automatically held more securely as the pressure of the cut increases.

Before placing a piece of work on this mandrel, the split sleeve should be placed so that a zero mark on it coincides with a similar mark on the main mandrel; this locates the sleeve in

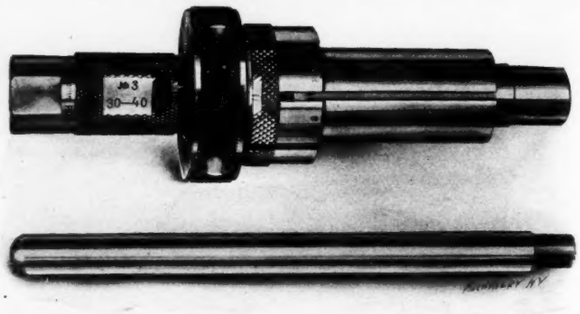

Fig. 1. Bergstrom Expansion Mandrel

correct relation with the spiral surfaces. When the work is inserted, the sleeve is twisted by hand, and a surprisingly strong grip may be obtained in this way. After a cut is started, the part being machined is automatically tightened by any retardation due to the cut. When a finished piece is to be removed, the serrated nut to the left of the sleeve is used to

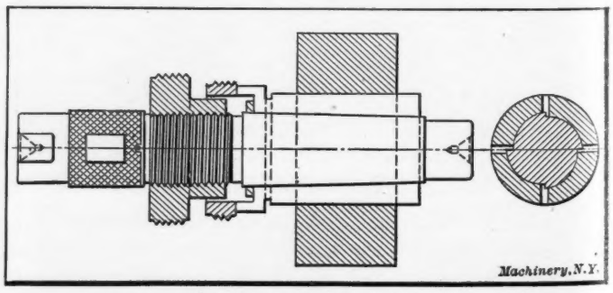

Fig. 2. Sectional View of Bergstrom Expansion Mandrel

force the latter off the main mandrel. If this nut cannot be turned by hand, a bar similar to the one shown in Fig. 1 is used, there being holes in the nut for the reception of the bar. This mandrel is made in eight different sizes.

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PRATT & WHITNEY THREAD AND SPIRAL GEAR MILLING MACHINES

An attachment which has recently been developed by the Pratt & Whitney Co., of Hartford, Conn. for the milling of internal threads, is shown applied to the Pratt & Whitney thread milling machine in Fig. 1. This attachment is rigidly constructed, and it forms a complete unit so that it may be readily accommodated to the regular carriage.

The proper relation between the carriage and attachment is maintained by means of long dovetail bearings and a taper gib which may be readily adjusted for wear. The cutter head is so mounted that the necessary swiveling action for setting the cutter to different angles, when cutting threads of different lead, is obtained without disturbing the central relation between the cutter and the work. The cutter may be accurately set to any angle within the capacity of the head by suitable graduations. When the cutter head is properly located, it is securely clamped to its seat by means of bolts. The cutter spindle is made of tool steel and is hardened, ground and lapped. A taper hole is provided for the reception of cutter arbors, and there is a draw-back bolt for holding the arbors in place. The bronze sleeve or box in which the spindle runs, is

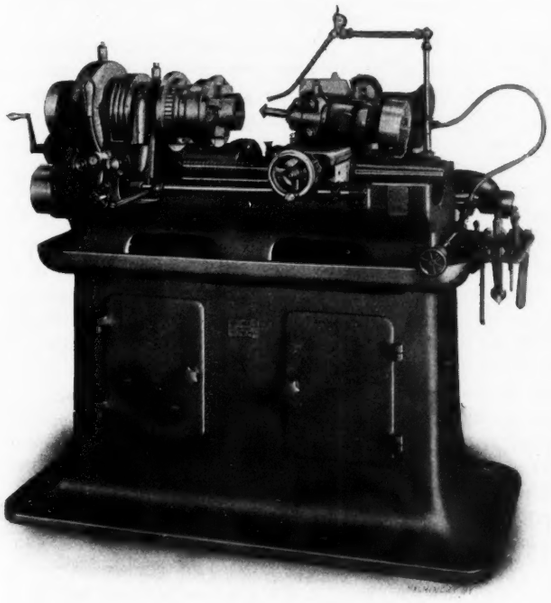

Fig. 1. Pratt & Whitney Thread Milling Machine with Internal Milling Attachment

mounted in the head in such a way as to permit the spindle to be adjusted longitudinally, which is very convenient when resetting the cutter to a previously cut thread. The drive for the cutter spindle is taken direct from the main driving shaft in the rear through gearing. Any tendency on the part of the cutter to chatter, owing to backlash in the driving gears, has been eliminated by the introduction of a flywheel. This flywheel which may be seen to the right of the carriage in Fig. 1, is mounted in bearings that are independent of the spindle. The cutter head has a very accurate and positive control, laterally, by means of a micrometer dial and positive adjustable stop. The latter enables the cutter to be withdrawn from the work and accurately returned for taking a cut of the same depth.

The necessary variations in the speed of the work spindle are obtained by means of a gear box at the rear of the machine. Eighteen speed changes, ranging in geometrical progression, are obtained by means of this gear box for each of the three driving pulley speeds, thus giving a total of fifty-four changes. Variations in the carriage travel for threads of different lead are obtained by change gears at the left end of the machine.

This machine has a compound spindle, consisting of an outer hollow spindle, which carries the driving mechanism and the spindle gear, and an inner hollow spindle containing the nose-piece and collet and also a notched index ring as shown. The two spindles are normally locked together by a pawl on the outer spindle, so that indexing, when cutting a multiple thread, is accomplished by simply releasing the pawl and turning the inner spindle one-half, one-third, or one-fourth of a revolution, etc., depending upon whether a double, triple, or quadruple thread is being cut. Both the cutter head and work spindle are driven by one belt, operating on a three-step cone pulley that is mounted on the left end of a splined driving

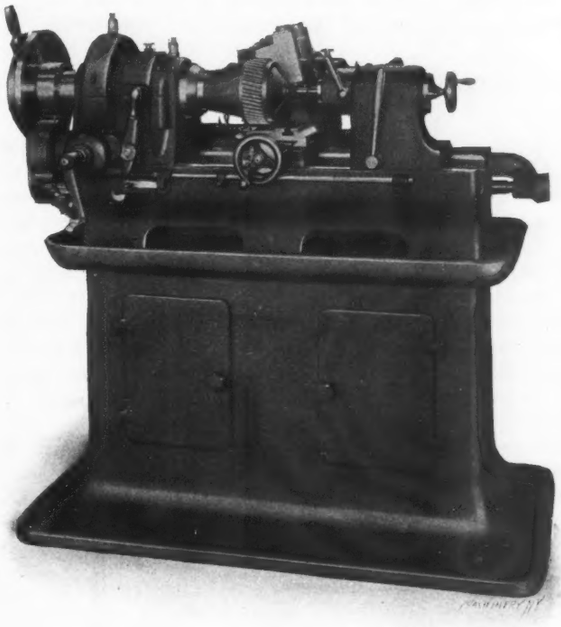

Fig. 2. Pratt & Whitney Spiral Gear Milling Machine

shaft at the rear. This splined shaft drives the cutter through gearing as stated, and the work spindle through the various ratios of gearing in the feed box.

In Fig. 2 a machine is shown that has been especially designed for milling spiral gears. The work is held on an arbor that grips the rim of a gear blank, so that it is well supported. As the engraving shows, the cutter is mounted in an adjustable head at the rear. Variations in the lead spiral are obtained through change gears, as with the thread milling machine. Three cutter speeds are provided and there are eighteen carriage feeds for each cutter speed, obtained by means of a geared feed box at the rear. The indexing mechanism may be quickly operated, and it is built on the same principle as that used on the Pratt & Whitney rifling machines. The indexing plates are very accurately made, and are much larger

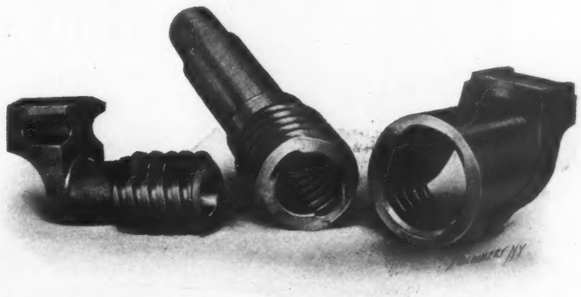

Fig. 3. Examples of Internal and External Thread Milling

in diameter than the gears, thus insuring accuracy. The longitudinal feeding movement of the carriage is controlled by the vertical lever seen in front of the headstock, and the feed may be automatically tripped at any predetermined point by an adjustable dog on the trip-rod at the front. The cross-slide is provided with a positive stop and a micrometer dial for setting the cutter to depth, and the carriage may be rapidly returned for a new cut by the crank on the left side of the machine.

In the operation of this machine, the cutter, which should be on the right side of the work, is fed in to the correct depth as

determined by the stop. The carriage is then traversed by hand until the cutter is almost in contact with the work, after which the power feed is engaged. After the cutter has fed across the face of the gears, the feed is disengaged by the automatic stop; the cutter is then moved back to clear the work and the carriage is rapidly returned by hand. After the work has been indexed for a new cut by means of the lever on the left end of the spindle, the cutter is again fed in to depth, and the feed engaged. From the foregoing it will be seen that the operating requirements of this machine are very simple.

ALL-GEARED MULTI-SPINDLE DRILLING MACHINE

In drilling operations where a number of holes of about the same diameter are required, the multi-spindle drilling machine has been of great value to the manufacturer, owing to the short time in which any number of holes within the range of a machine of this type, can be drilled. An interesting design of multi-spindle machine that has been placed on the market by The Walter H. Foster Co., 50 Church St., New York City, is shown in Fig. 1 of the accompanying illustrations. This machine has been designed to get efficient service from high-speed drills when operating on the tough alloy steels which are now used quite extensively, particularly in the construction of automobiles.

The distinctive feature in the construction of this machine is the drive, which is an all-geared type, and has been adopted as a means of transmitting sufficient power to the drill points to meet modern requirements, without undue strain or wear

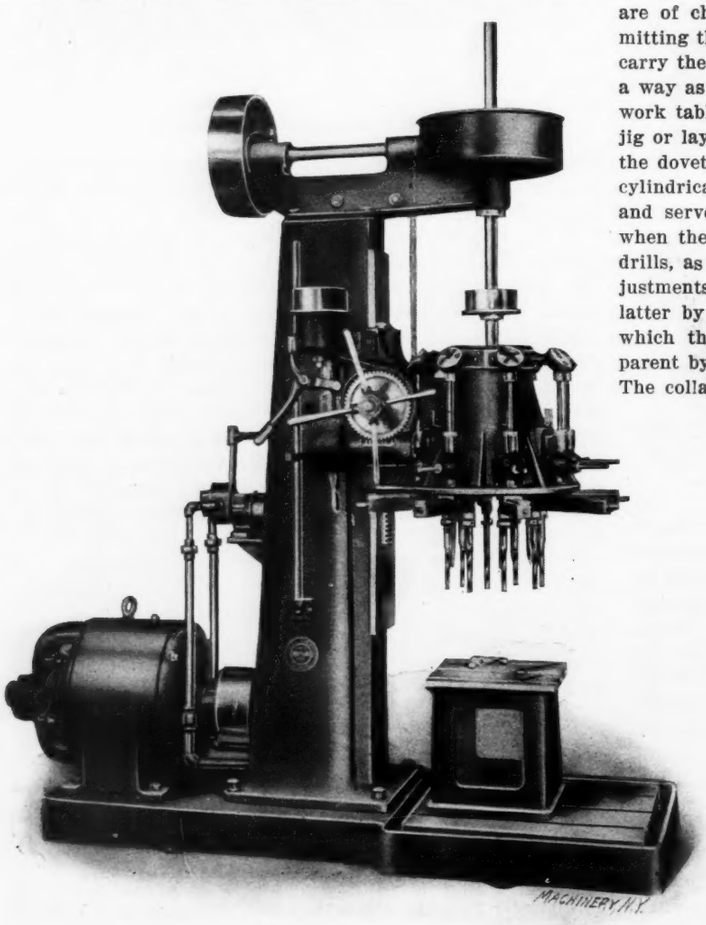

Fig. 1. Multi-spindle Drilling Machine, the Spindles of which are driven by Bevel Gears

on the adjustable and moving parts. In addition to the substitution of gears for universal joints, other important features in the construction are, the introduction of steel, where cast iron was formerly used, and the improved method of adjusting the spindles, either horizontally or vertically, to any desired position, within their range.

The spindle or drill head is of conical box pattern, braced to insure rigidity. This head is so designed that the spindles can be set to drill any layout, whether circular, square, or in a straight line, as shown by the diagrams, Fig. 2. The machine is driven by a 2 to 1 variable speed motor, which is con-

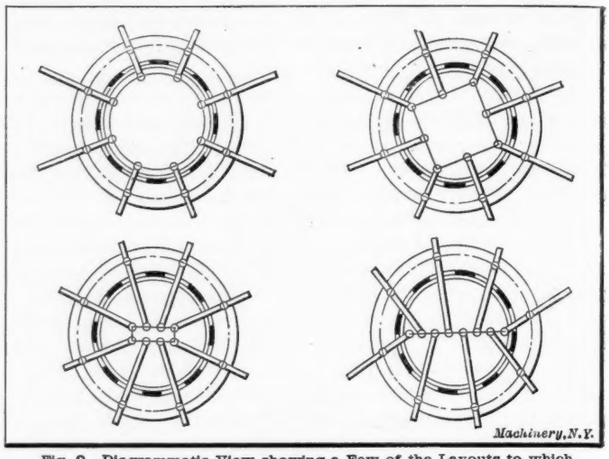

Fig 2. Diagrammatic View showing a Few of the Layouts to which the Spindles may be set

nected by a 4-inch belt to a 16-inch pulley on the horizontal shaft at the top of the column. The method of transmitting power from the central driving spindle, by bevel gears instead of universal joints, is clearly indicated in the sectional view, Fig. 4. The small bevel gears employed in this drive are of chrome-nickel steel, hardened and encased, thus permitting them to run in lubricant. The adjustable arms which carry the drill spindles are attached to the drill head in such a way as to always maintain the drills at right angles to the work table—a feature which facilitates setting the drills to a jig or layout. The arm, which is of cast steel, is mounted in the dovetail ways of a machinery steel saddle *A* which has a cylindrical projection or pintle that fits into the head casting and serves to maintain the vertical position of the spindle when the nut *B* is loosened for making an adjustment. The drills, as before stated, have both horizontal and vertical adjustments, the former being obtained by a screw *C*, and the latter by turning the knurled collar or nut *D*. The way in which the vertical adjustment is effected, will be more apparent by referring to the enlarged view of the spindle at *E*. The collar *D* fits over a threaded part of the spindle and it has an annular groove which engages a pin that passes through the drill socket and extends on either side as shown. By this simple means, the drill socket may be moved up or down to any position within the length of the spindle slot which contains the cross pins. This vertical adjustment is of special value, as it enables the operator to start all the drills cutting at the same time, and it also provides for a considerable range of stepped drilling. As each spindle has a maximum movement of 1½ inch, surfaces lying in planes 3 inches apart can be drilled.

The spindle head has a bearing surface on the column of 20 by 9 inches and it is properly gibbed to compensate for wear. The column is of heavy box section and it contains the counterbalance for the drill head. The base has a working surface of 30 by 28 inches, and the box table is 16 inches square by 16 inches high. The working surface of the base is surrounded by an oil groove which is connected with the main oil reservoir that is cast integral with the base. The oil pump for supplying lubricant to the drills, is located on the rear of the column and is belted direct to the motor, or to a countershaft when a belt drive is employed. The lubricant is pumped to an auxiliary reservoir in the head, whence it is conveyed to each drill through a spiral flexible hose, as shown in Fig. 4, the supply being controlled by valves *F*.

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Power feed is imparted to the drill head through a geared feed box, a sectional view of which is shown in Fig. 3. This feed box gives three changes that are obtained by manipulating lever *L* which operates a diving key. The feeding movement is transmitted to the head through a hardened steel worm which meshes with a large bronze worm-wheel *W* connected with pinion shaft *S* by a clutch on the pilot wheel *D*. The pinion and shaft *S* are integral and the former engages a wide steel rack secured to the column. The feed may be thrown in or out by hand lever *L*, and it may be automatically tripped at any point by the adjustable dog *E*. The drill head may be quickly traversed in either direction by pilot wheel *D*, after disengaging the clutch on its hub with a corresponding clutch on the worm-wheel.

All the spindles are driving shafts used in the construction of this machine run in bronze bushings, and all bearings are provided with ample and accessible lubricating facilities. The gears are made either of steel or bronze and they are properly guarded and hardened where necessary. The drill spindles have Hess-Bright radial and thrust ball bearings, and the feed worm also has a thrust ball bearing.

The machine illustrated has a capacity for high-speed drills, ranging from ¼ to ½ inch in size, and holes may be drilled

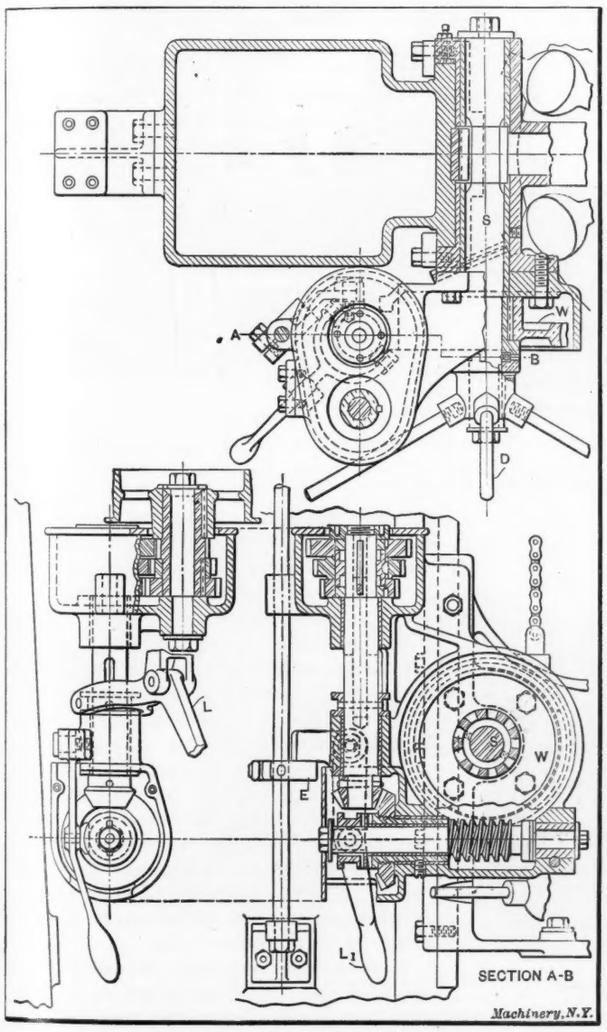


Fig. 3. Sectional View of Feeding Mechanism

outside a 4½-inch, and within a 12-inch circle. The minimum center-to-center distance between the spindles is 1¾ inch. Other standard sizes are equipped with four, six, eight, ten, and twelve spindles, suitable for drilling 1-inch holes within a circle having a maximum diameter of 24 inches and outside a circle having a minimum diameter of 9 inches. Standard heads can also be furnished having a capacity for twelve and sixteen ½-inch holes within a rectangular surface measuring 16 by 20 inches.

TWENTIETH CENTURY STOCK RACK

The metal stock rack illustrated herewith is a recent product of the Manufacturing Equipment and Engineering Co., of Boston, Mass. The uprights of this rack are composed of a central sheet of light gage, bound on each edge by a heavy

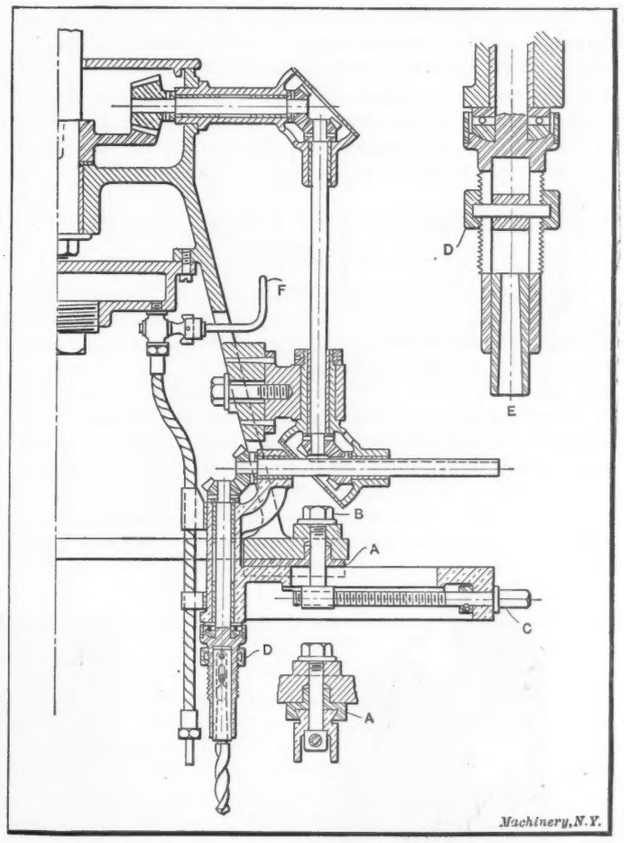
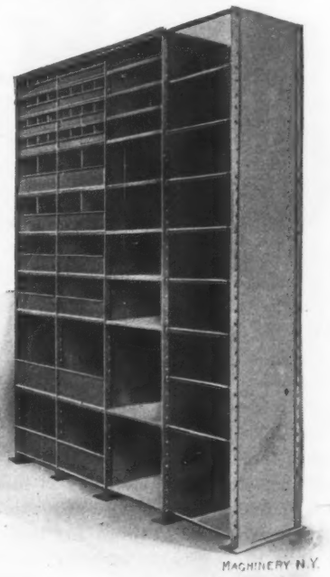


Fig. 4. Section of the Head showing All-geared Spindle Drive

gaged sheet formed into a triple V and forced onto the central sheet. These stiffening strips have a series of holes punched at intervals of three inches throughout their length, for carrying the truss bars that support the shelves. When these holes are punched, a burr is carried down through all the sheets, thereby securing the central sheet to the stiffening edges on both sides. It will be seen that these edges form a direct support for load, as the truss bars are bolted into the punched holes. The partitions of this rack are usually located 18, 24, 30, or 36 inches apart, though any desired width can be furnished. The truss bars are made of tubing and have angular braces or knees riveted on each end, by which they are bolted in place. This construction enables the shelves, which are carried directly upon these bars, to be placed at any desired distance apart. The shelves are made of a gage suitable for the load. They are flanged



Metal Stock Rack with Adjustable Shelves

and trussed on the front and back edges, and there are also flanges on the ends, thus enabling a light sheet to carry a heavy load. The shelves are pierced to take a card-holder on the front and dividing partitions. The bin fronts are formed to hook under the shelves, and they can readily be swung up into place. They are flanged on the ends and are held in place by bolts passing through the flanges and uprights. The top edge is trussed and left broad to permit the use of the fronts as a ladder. These fronts can be made for any desired height of bin and they are readily removed or put in place. The shelves are punched to admit intermediate partitions, either crosswise or lengthwise. Backs can be supplied when desired. They are formed on either edge and are pierced so that they can be bolted to the back of the shelves.

UNIVERSAL WOOD GEAR CUTTING MACHINE

The Newark Gear Cutting Machine Co., 66 Union St., Newark, N. J., has brought out a new machine that is used for cutting the teeth of wood gears for patterns, and it is especially adapted to spiral or helical gear work. There is a wide field in which heavy cast-tooth "herringbone" or double helical gears are required, and such gears can be cast solid from patterns cut on this machine. A pattern for gears of this type is made in two pieces, having right- and left-hand spirals, but the casting is, of course, solid.

This machine, which is illustrated in Figs. 1 and 2, has a capacity for spur gear patterns up to 8 feet in diameter by 24 inches face, and it will take helical or spiral gear patterns as large as 7 feet in diameter by 24 inches face width. Worms of any lead or angle and with any number of threads, may be cut, as well as helical gears of any lead or angle. Blocks of wood for use in gear-tooth molding machines may also be cut on this machine. The range of pitches which it is capable of cutting is, of course, very large. By using fly cutters, all pitches ranging from 1 inch circular up to 7 inches circular, can be easily taken care of, and heavier pitches can also be cut if necessary. The finer pitches, when required, are cut by using regular rotary gear cutters.

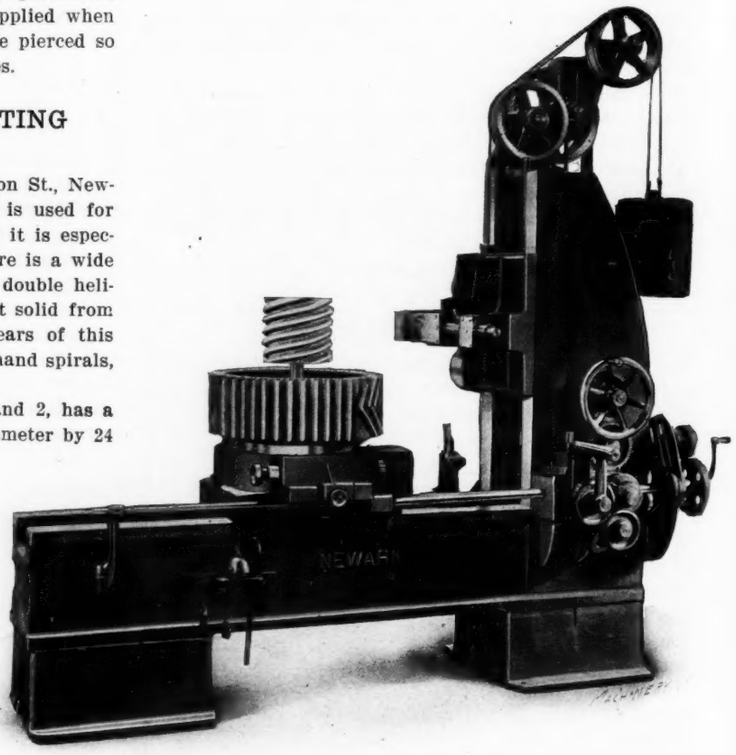


Fig. 1. Machine for Cutting Wood Gear Patterns—Examples of Work on Machine

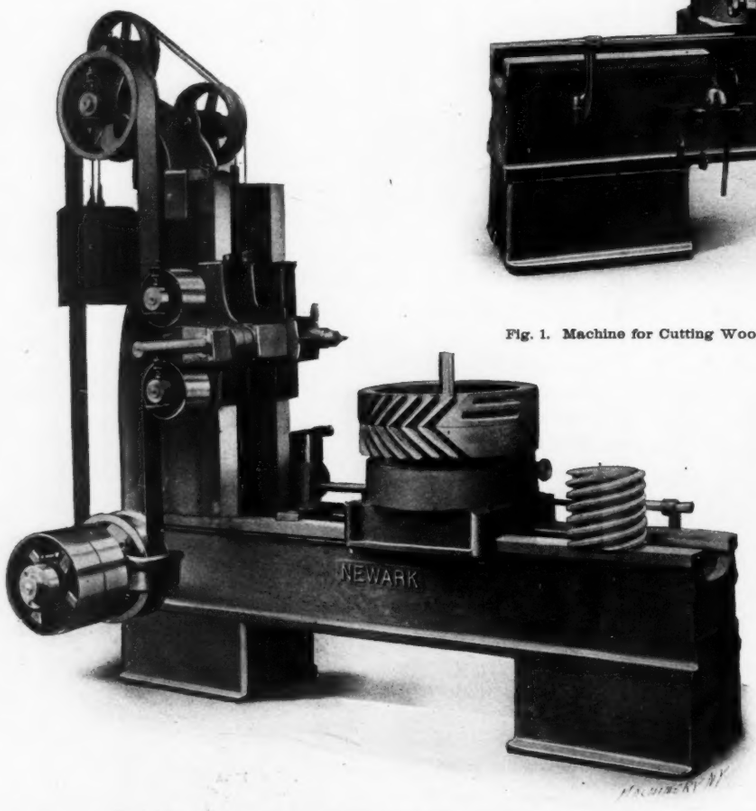


Fig. 2. View of Wood Gear Cutting Machine showing Drive to Spindle

Owing to the nature of the material which this machine handles, there are several features in its construction which differ from those found on a standard metal gear cutting machine. The feed is obtained by means of a handwheel which operates a screw equipped with ball thrust collars. This hand feed is used so that the operator can vary the feed to suit conditions. A fast feed would be employed during a full cut, though a reduction might be necessary, owing to changes in the grain of the wood. A comparatively slow feed would also be necessary when the end of the cut was reached, or when the cutter encountered a knot. After each tooth is cut, the cutter slide, the weight of which is equalized by a counterbalance, is returned for a new cut which is taken after the blank is indexed by a hand crank. The indexing is obtained by means of change gears, thus avoiding the use of dials and the chance of spoiling work because of mistakes in using the dials. With this machine the operator makes one or more even turns of the crank, according to the index required. All numbers of teeth up to 100 can be cut, and all numbers from 100 to 450, excepting prime numbers, above 100. A wide range of numbers above 450 can also be cut. When any unusual number is required, this can be arranged for by means of extra change gears.

In operation, the wooden pattern blank is mounted upon the work arbor, or directly upon the faceplate. A rim support is provided for taking the thrust of the cut on large gears. The faceplate is integral with the dividing worm-wheel which is made in two sections and generated in place to secure accuracy. The dividing worm may be disengaged from the wheel to permit the blank to be rotated by hand. This worm is provided with an adjustment for use in resetting, or when taking side cuts. A complete guard protects the worm and wheel from dust and dirt. The work head may be adjusted longitudinally on the bed to take care of patterns of various diameters, by means of a screw having a dial graduated to thousandths of an inch.

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The simple method of driving the cutter spindle is shown in Fig. 2. An endless belt is employed which passes around an idler pulley at the top and a small pulley on the cutter spindle to which it is guided by idlers on the slide. The drive to the machine itself is to a tight and loose pulley arrangement, as the engraving indicates. These pulleys are mounted upon a rigid sleeve, and not upon the shaft, thus relieving the latter of all strain from the belt pull.

The form of cutters used on this machine for heavy pitches, are shown in the illustrations. When cutting spur gear patterns, a formed fly-cutter is used, which is mounted upon the spindle as shown in Fig. 1. This spindle makes 3200 revolutions per minute. When cutting helical gears or worms, an end-mill form of fly-cutter is used, which is mounted upon the end-mill attachment shown in Fig. 2, through which the cutter is driven at the rate of 4200 revolutions per minute. These cutter spindles are of high carbon steel, accurately ground, and run in phosphor-bronze bearings.

Although this machine has been designed for cutting wood, the construction shows a careful distribution of the metal to insure rigidity. The bed has a deep section and the box form of construction is used, which eliminates the tendency of vibration that would otherwise result with this class of work. As an illustration of the rapidity with which work can be done in this machine, the makers state that a wooden spur-gear pattern having 40 teeth of 3-inch circular pitch and an 8-inch face width was cut in thirty minutes' actual cutting time. As the driving pulley of this machine runs at a constant speed, a motor drive can readily be employed if desired.

MORRIS 20-INCH CONE-HEAD LATHE

A design of 20-inch cone-head lathe now being manufactured by the John B. Morris Machine Tool Co., of Cincinnati, Ohio, is shown in Fig. 1. The headstock of this machine is long and massive and entirely encloses the face gear. It is equipped with a three-step cone pulley and double back-gears, giving ratios of 4.4 to 1 and 18 to 1, with speeds arranged in geometrical progression.

A general idea of the construction of the headstock may be obtained by referring to the sectional plan view, Fig. 2, which shows the arrangement of the gearing, spindle bearings, etc.

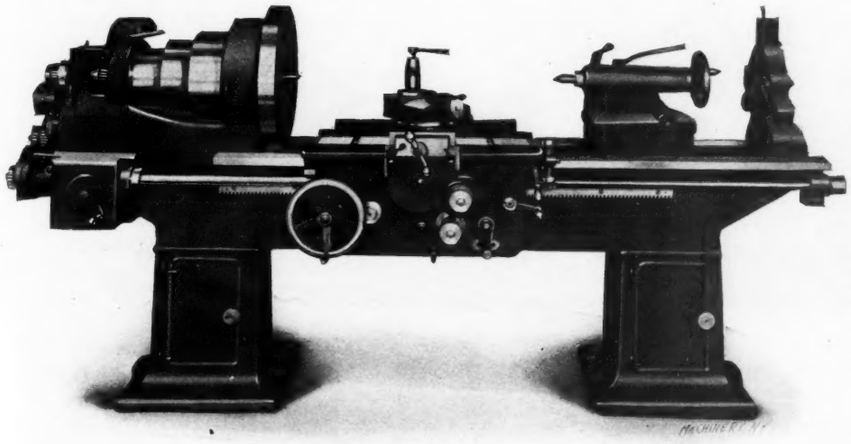


Fig. 1. Twenty-inch Cone-head Lathe built by the John B. Morris Machine Tool Co.

The cone pulley has a double gear keyed to it which meshes with the sliding gears *N* on the back-gear quill, and the pinion *O* of this quill meshes with the face gear, which is keyed to a flange on the spindle outside of the front spindle bearing. This method of driving makes it impossible to lock the cone pulley to the spindle in the usual manner, and to accomplish this a plate *A* having a number of holes drilled in it, is keyed to the spindle. This plate is engaged for a direct drive by the spring seated plunger *B*, which has a knurled knob *C* on its left end and a retainer pin *D* to keep *B* out of engagement with the holes of plate *A*, when the back-gears are in use. The knob *C* is operated by hand through the opening in the gear cover, seen in Fig. 1.

It will be noticed that the headstock bearings both in the front and back, are tapered and ring oiled. The headstock boxes are not capped, but are solid bearings, bored the same size front and back. The bronze sleeve *E* is fitted into the front bearing a light driving fit, and its bore corresponds to the spindle taper. It is keyed to prevent rotation, and a left-hand thread is chased on its inner end to receive the adjusting nut *F*, which has a right-hand thread on its hub to fit into

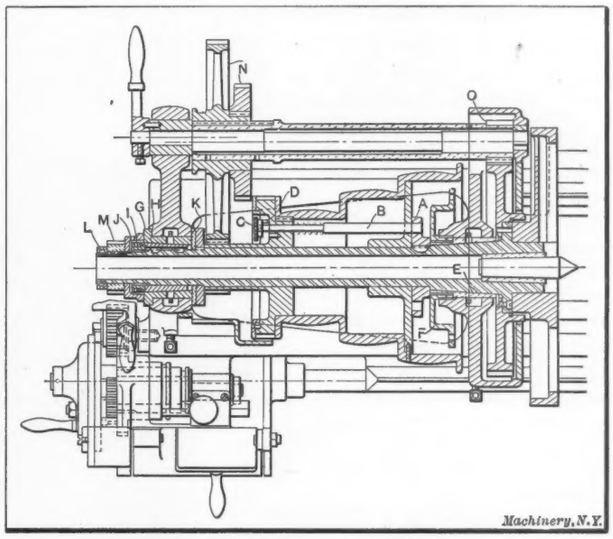


Fig. 2. Sectional View of the Headstock

the headstock. The nut *F* has a large flange, drilled to receive the pins of a face spanner wrench, which is supplied for making adjustments. A small cover shown in the enlarged portion of the headstock to the right of the cone pulley, Fig. 1, may be removed for adjusting this nut or to inspect the front bearing. The rear bearing of the spindle has a bushing *G* that is driven into the headstock, and this bushing is bored tapering to receive a sleeve *H* keyed to slide on the spindle. This sleeve is moved longitudinally by adjusting nut *I*, operated by a spanner, engaging the slots in thrust cup casting *J*. The thrust of the lathe spindle is opposed by the hardened tool steel washer *K*, and the spindle is confined longitudinally by the nut *L* on its outer end and the feed gear *M* which bears against the cup *J*, which in turn rests against box *G*.

The spindle is made of high-grade crucible steel and it has a 1⅝-inch hole extending through it. The nose of the spindle is 3½ inches in diameter, and it serves as a pilot for the faceplate or chuck plates, which screw directly into the face gear. The apron of this machine is double webbed, and all shafts which are subjected to severe strain are given double support. By means of a lever on the apron, a positive feed may be engaged for rough-chasing all threads with the ordinary rack feed to preserve the lead-screw for finishing. Provision is made for keeping the rack and screw feeds out of engagement at the same time, and also for reversing the cross and longitudinal feeds of the apron. The thread-cutting capacity ranges from 2 to 72 threads per inch, including 11½ pipe thread, and a chasing dial is provided for "catching" the threads without stopping or reversing the lathe. The semi quick-change box gives three changes of feed for every change of gears, and the variations, which range from 0.005 inch to ½ inch per revolution of the spindle, are obtained by the movement of a lever. The compound rest has a long traverse and is accurately grad-

uated on the entire circumference. The countershaft has double 14 by 4 inch friction pulleys, and both belts may run forward, as no backing belt is necessary.

This lathe swings 20¾ inches over the ways and 12½ inches over the carriage. When the tailstock is flush with the rear end of the bed, the 8-foot machine will turn 4 feet 5 inches between the centers, and an extra length of 5 inches may be obtained when the tailstock is overhung. The 8-foot lathe weighs approximately 3700 pounds.

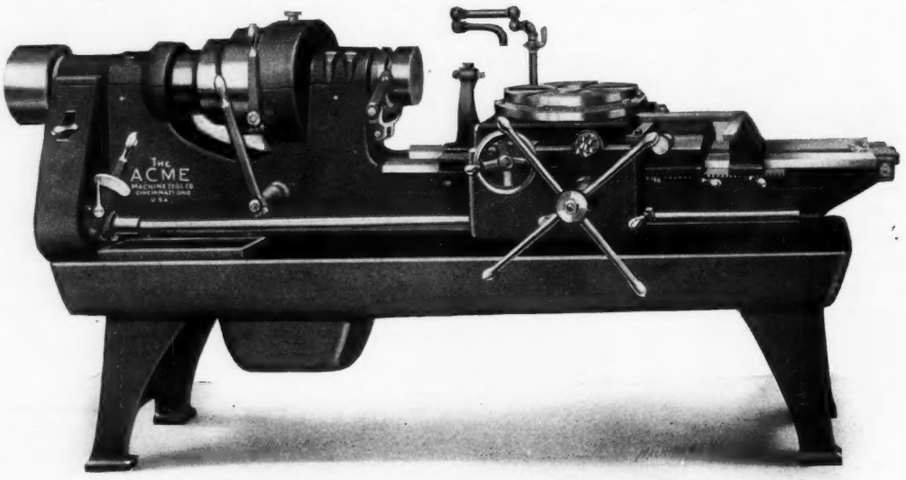
REED HEAVY-DUTY LATHES

A new line of heavy-duty lathes of the double back-geared type, has been brought out by the F. E. Reed Co., Worcester, Mass. These machines range in size from 18 to 30 inches, and a general idea of the design may be obtained from the accompanying halftone, which shows a 24-inch size.

All parts, such as the bed, headstock, tailstock, carriage and apron, have been made extra heavy to enable these machines to handle the class of work for which they are designed. On the 24-, 27- and 30-inch lathes, the headstocks are equipped with four-stepped cone pulleys, while the 18-, 20- and 22-inch sizes have three-step cones.

These lathes have a quick-change gear mechanism by means of which sixty changes for both the lead-screw and feed-rod are obtained. Thirty of these changes are effected by the manipulation of a lever at the top of the box in conjunction with the tumbler gear bracket shown, and this number is doubled by a sliding gear at the end of the lathe. Connection is made with either the lead-screw or feed-rod by the star knob, shown to the right of the gear box, and the arrangement is such that the lead-screw and feed rod cannot be connected at the same time. A detailed description, accompanied by a phantom illustration showing the interior mechanism of this gear box, was published in the department of New Machinery and Tools, May, 1910. All the gears in the front case are of steel and have teeth of coarse pitch.

The lead-screws are equipped with thread-cutting indexes. The apron feed works are driven by worm and worm-gears, and there are double frictions for longitudinal and cross feeds. The tool-rests are made in both the compound and plain types, and a taper attachment can be supplied with either style of rest. The countershaft is of the two-speed friction type, and the hangers are equipped with self-oiling boxes. This line of lathes is particularly adapted for railroad work and all kinds of heavy turning.

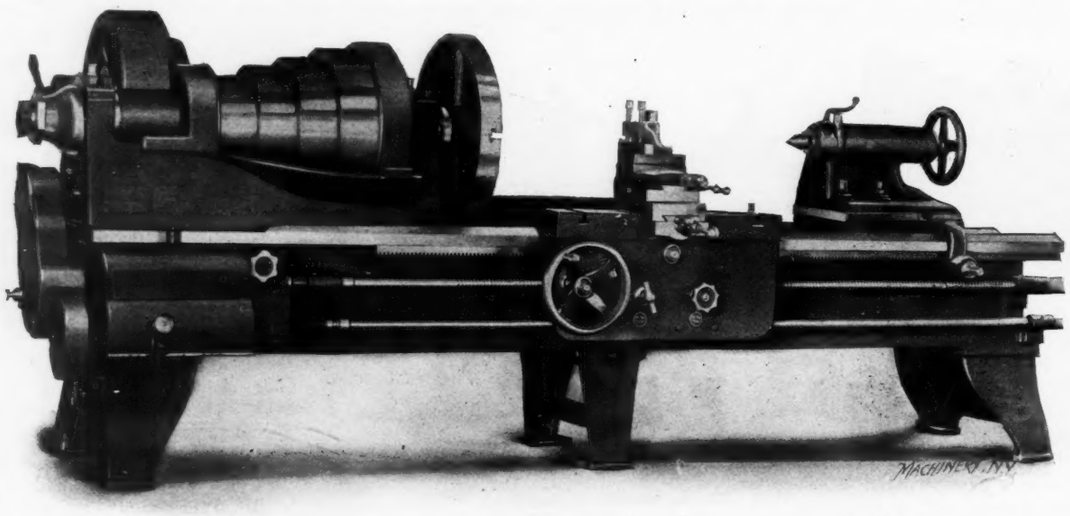


Acme 21-4- by 26-inch Combination Turret Lathe

ACME COMBINATION TURRET LATHE

A combination turret lathe has been designed by the Acme Machine Tool Co., Cincinnati, Ohio, to meet the demand for a first-class machine adapted to the production of parts from bar stock, and also to the machining of forgings and castings, with the use of simple tools. This machine, which we illustrate herewith, handles bar work up to 2¼ inches in diameter and 26 inches long, with the bar outfit of tools; and forgings or castings up to 14 inches in diameter may be machined with the chucking outfit. The machine will swing diameters up to 19 inches.

The head is cast solid with the bed, thus insuring rigidity, and it is provided with friction back-gears and a three-step cone taking a 3½-inch belt. The spindle is of high-carbon, hammered, crucible steel and it is provided with ring oiling babbitted bearings. The bed rests on three points in order to avoid all twisting action. The chuck is especially designed to insure holding the work accurately, and it has great gripping power. It is opened and closed, while the machine is running, by means of the long lever shown at the front of the head; this lever also operates the roller feed. With this chuck the work does not have an "end motion" when the chuck is closed, so that second operation work requiring



F. E. Reed Co.'s 24-inch Double Back-geared Lathe

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exact shoulder lengths may be handled, and the jaws do not overhang, allowing short work to be gripped without tilting them. The jaws are easily removed and inserted without dismantling the chuck.

A roller feed of improved design is used for feeding the stock, in which the centering jaws and rolls are operated together automatically. When setting the roller feed for any size stock, an adjustment is made by turning a spanner wrench until the jaws grip the stock; they are then loosened a trifle, after which the rolls are under the proper tension for feeding. Bars of any section, whether round, square, or hexagonal, can be handled.

The turret consists of a circular plate having radial locating slots for the tools and also bolt holes for clamping the tools. The locking bolt for the turret is placed at the front end of the slide directly under the cutting tool, and works in hardened and ground taper bushings set into the solid turret. An oil hole is provided under each tool space for use with oil tube drills, etc., in addition to the regular oil pipe. A swinging stock-stop is attached to the front of the saddle.

The cross-slide, which is of generous proportions, moves on a narrow dovetail guide having a gib for taking up wear. It has hand and power cross-feeds in both directions, and a large micrometer dial giving direct measurements. Independent adjustable cross-stops are provided for each tool on the turret. These stops are convenient to the operator, and the combination can be varied as desired. A very rigid stop is used to locate the turret in its central position, all movements of the cross-slide being from the center outward.

The carriage has a full length bearing on the V's which are of large proportions, and it is securely held by gibs at the front and rear ends. Automatic adjustable stops are provided for each station of the turret and there are four auxiliary stops which may be used in any combination desired; these are controlled by the knob seen at the right end of the carriage. All these stops trip the automatic feed.

Power feed is provided for both the cross and longitudinal movements of the turret. This feed is of the geared type and gives four changes which may be quickly obtained by moving the lever shown at the front of the head. Both feeds are reversible by means of the lever at the front of the feed box.

An ample supply of oil is provided by a pump which operates with the machine running in either direction. The oil tank is cast solid with the large chip pan, and it is provided with a perforated cover which strains the oil. All the working parts of this machine are carefully protected from dirt and chips, thus insuring accuracy. An improved stock-supporting stand and a triple friction countershaft with ring oiling boxes is furnished with each machine. A motor drive can be supplied upon special order.

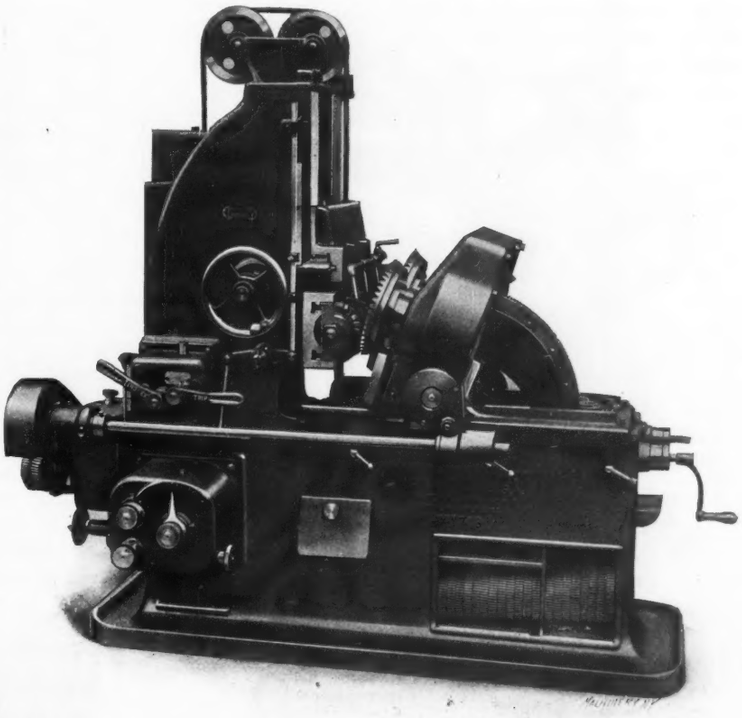
GOULD & EBERHARDT MULTIPLE-SPINDLE AUTOMATIC GEAR-CUTTING MACHINE

A multiple-spindle automatic gear-cutting machine for spur and bevel gears, worm-wheels and clutches, is now being manufactured by Gould & Eberhardt, of Newark, N. J. This machine, which is illustrated herewith, is a "manufacturing tool" that is capable of cutting one, two, or three spur or bevel gears, worm-wheels or clutches, simultaneously—thus materially reducing the time per piece—and it is especially adapted for roughing out bevel gears preparatory to finishing them on a bevel gear planer.

The illustration shows a 24 by 8 inch machine, equipped with two spindles on which are mounted two 49-tooth, 5-pitch steel gears having a face width of 1 5/16 inch. The time required for roughing out two of these gears is 36 minutes, or 18 minutes each, this being the actual cutting time. This machine is practically the same as the Gould & Eberhardt machine illustrated in the department of New Machinery and Tools for January, the chief difference being in the special cutter and work slides.

The cutter slide is arranged to accommodate one, two, or three cutters, and the cutter spindle bearings are so located that each cutter has a bearing close to it on both sides, so that a rigid support is secured. The slide is actuated on the draw-cut principle; that is, the feed-screw is anchored in the base of the stanchion so that it is under a tensile strain which overcomes the vibration that would take place if the screw were placed under compression by being anchored at the top part of the stanchion. The strains from the thrust of the cut are also transmitted to the base of the machine, when the feed-screw is anchored at its lower end.

The cutter, feeding and indexing mechanism of this machine are driven in a direct manner, and ball bearings are provided to take care of thrusts, where needed. The feed and return



Gould & Eberhardt Gear-cutting Machine, especially adapted for Roughing Bevel Gears

of the cutter slide, and the indexing, are controlled by only two levers that enable the operator to return the cutter slide by power without the necessity of unlocking the indexing mechanism. This mechanism also provides for a safety device that holds the cutter slide from feeding while indexing of the work is taking place, it being impossible for the feed to start until after the indexing operation is completed.

The work slide is provided with three work spindles which are controlled by a positive indexing mechanism. The spindles are indexed in unison by means of helical gears located directly under the blanks being cut. When all the spindles are in use, which enables three gears to be cut simultaneously, bevel gears up to 5⅛ inches in diameter can be machined. When only the two outer spindles are used, bevel gears up to 10¼ inches in diameter can be machined, while the use of only one spindle enables a gear of 24 inches in diameter to be cut, which size represents the maximum capacity of the machine.

In addition to the regular segment support to the table, the angular position of which is controlled by a worm and worm-wheel sector centrally located and securely held by an extra clamping device, there is a special adjustable brace which supports the periphery and also the back of each blank being cut, at a point opposite the cutters. This brace also acts as a chip

chute and directs the chips and oil into a pocket located in the base of the machine, where the oil is strained and thus separated from the chips before it again reaches the oil pump. This combination of supports gives a rigid and solid construction, which is, of course, very essential to rapid production. This machine weighs approximately 3500 pounds, and as the illustration shows, it is equipped with guards that entirely cover every running gear.

SUPERIOR UPRIGHT DRILLING MACHINES

The Superior Machine Tool Co., of Kokomo, Ind., is now manufacturing a new line of upright drilling machines, similar to the design illustrated in Fig. 1. These machines are built in sizes ranging from 21 to 36 inches. The geared type of feeding mechanism is employed, and the feed box, the worm box, and the head are all cast in one piece. The gear box provides four changes of feed, any one of which may be obtained while the machine is in operation. The feed variations

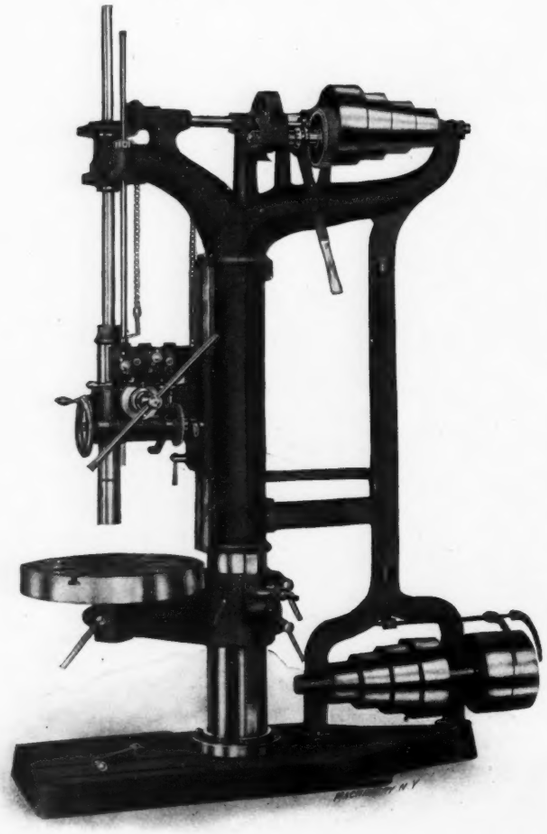


Fig. 1. Drilling Machine built by the Superior Machine Tool Co.

are controlled by two handles located on the side of the feed box as shown. These handles control the position of clutches C and C_1 shown in the sectional view of the feed box, Fig. 2. As the engraving indicates, these clutches may be brought into engagement with either of two clutch gears, mounted above and below them, thus giving the four changes. The method of transmitting power through the bevel gears and worm gearing to the pinion feeding shaft is clearly shown. The change gears are made from 3½ per cent nickle steel, heat treated. The spindles are forged from high-carbon steel and ground to size; in fact all spindles, sleeves, shafts and tight and loose pulleys are ground. The base and table are extra heavy and strongly built. The table arm and the head are provided with long bearing surfaces on the column, and the spindle and head are counterbalanced to insure easy operation. Three-step cone pulleys are used on the 21-inch machine, and four step pulleys on the larger sizes. These pulleys have extra wide and heavily-crowned faces. The patent tapping attachment made by this company can be applied to these machines if desired. All the principal parts of these machines are thoroughly tested with special micrometer testing machines, thus insuring perfect alignment and accuracy.

ROBBINS 16-INCH PATTERNMAKERS' LATHE

The Robbins Machine Co., Worcester, Mass., is now manufacturing the design of 16-inch patternmakers' lathe, shown in the accompanying illustration. This machine is rigidly built, the weight with a 6 foot bed being 1100 pounds. The head-

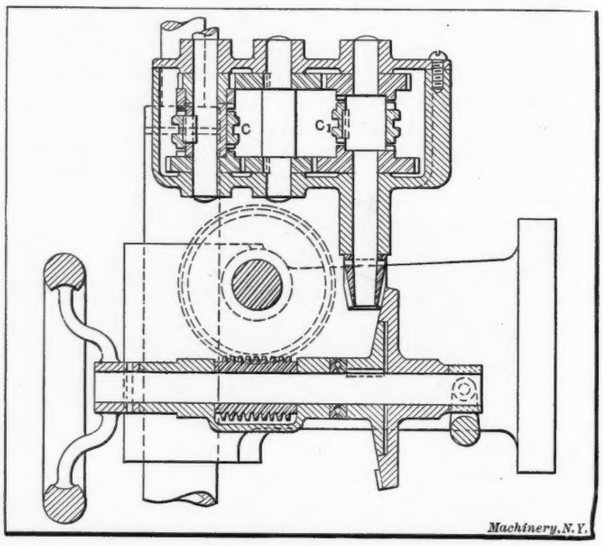
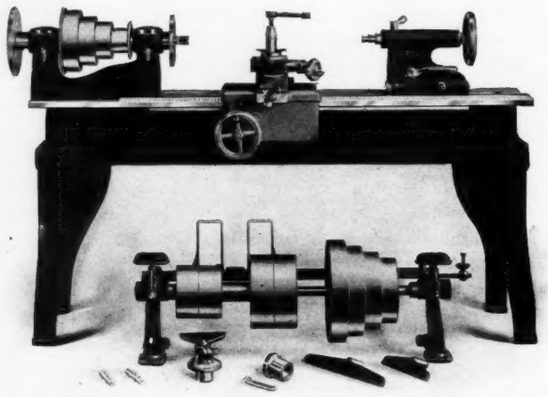


Fig. 2. Geared Feed Box of Superior Drilling Machine

stock spindle is of crucible steel, and runs in dust-proof ring-oiled bearings of phosphor-bronze, having large oil reservoirs. The spindle extends beyond the headstock on the left side, and is provided with a large faceplate for turning work that cannot be swung over the ways. The tailstock is of the cut away type, and the tail spindle is also of crucible steel, and has a long travel. The carriage has a hand feed, though a power feed can be supplied at extra cost, if desired. The compound slide has a graduated swivel, and the transverse adjustment is obtained by means of a screw of coarse pitch. If desired, the



Robbins 16-inch Patternmakers' Lathe

compound slide can be quickly detached and replaced with a swiveling holder carrying a tool rest for hand turning. The countershaft is provided with self-oiling hanger boxes, and two pairs of tight and loose pulleys of different diameters, for doubling the number of speeds obtained through the step cone pulleys. The countershaft has a patent belt shifter which requires but one handle for the operation of both belts.

This machine is built in 16-, 20- and 24-inch sizes. The 16-inch machine, illustrated herewith, swings over the bed 18¼ inches; over the carriage 13¾ inches; and it has a maximum distance between the centers on a 6-foot bed, of 39 inches. Each lathe is provided with a tripod rest; three hand tool

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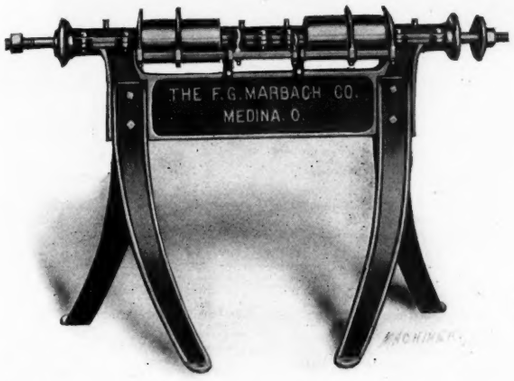
rests; one pair of wood centers; one pair of pointed centers; two faceplates; one screw plate, and the necessary wrenches. The workmanship is high-grade throughout, and each lathe is thoroughly tested at the speed at which it is intended to run.

MARBACH GRINDING OR POLISHING MACHINE

A grinding or polishing machine that is now being built by the F. G. Marbach Co., Medina, Ohio, is shown herewith. This machine is of the double-spindle type, and each spindle has an independent control. The spindle bearings and also those for the loose pulleys, are equipped with Randall's graphite sheet lubricator. The shifters are placed in a convenient position, so that the operator can start or stop either end of the machine instantly. As the engraving shows, the front legs are



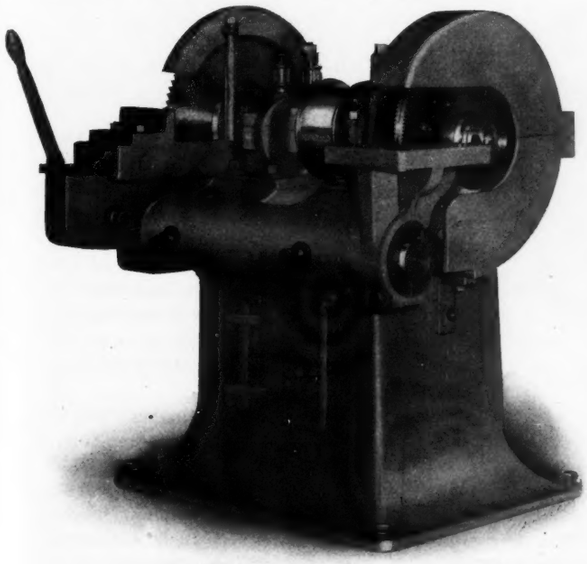
Grinding or Polishing Machine built by F. G. Marbach Co.

curved inward to give the workman plenty of standing room.

The principal dimensions of this machine are as follows: Distance between the wheels, 48 inches; length of the bearings, 8 inches; diameter of the spindle in the bearings, 1⅜ inch; length of the shaft over-all, 62 inches; diameter of the wheel flanges, 5⅜ inches; height from the floor to the center of the spindle, 36 inches; diameter and width of pulleys, 5¼ and 4¾ inches, respectively; weight, 340 pounds.

AJAX HOT SAW AND BURRING MACHINE

A hot saw and burring machine that should be a valuable addition to the equipment of a forging shop, has been recently brought out by the Ajax Mfg. Co., Cleveland, Ohio.

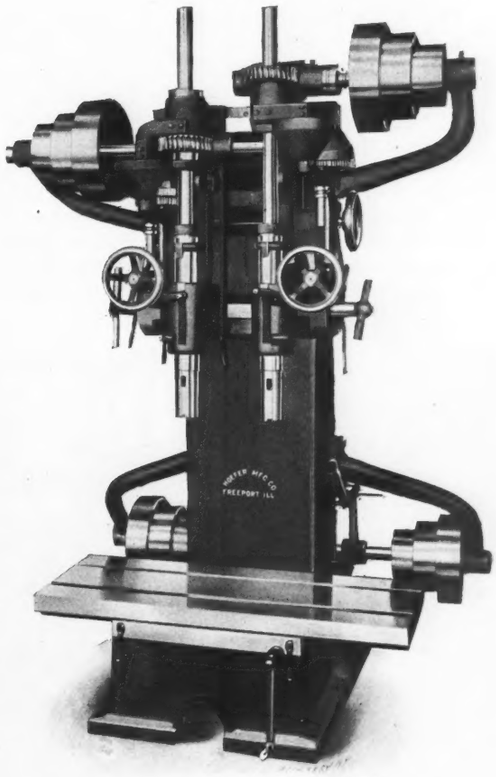


Combination Hot Saw and Burring Machine

This machine, which is shown in the accompanying halftone, is intended primarily for service in connection with an upsetting forging machine, and it was designed with the idea of further economizing in the production of machine made forgings. By the use of this machine a headed forging may be sawed from the bar immediately after it is upset, thus leaving a clean square end. The burrs or fins which are formed after a set of dies has been used, can also be rapidly removed. The general design of this machine is similar to that of a double-ended grinder or emery wheel stand. One end of the shaft or spindle carries a head that is fitted with a milled band on the periphery and a milled disk face on the side, as the engraving shows; this end is used for removing the fins or burrs from a forging which has been upset. The opposite end of the spindle carries a hot saw for cutting off the forgings from the bar. These machines are built in three sizes having saws and burring heads, 14, 20 and 30 inches in diameter. They operate at a high rate of speed, and, consequently, are built rigidly and equipped with large bearings and ample provision for lubrication. The utility of such a machine will be fully appreciated by the users of upsetting forging machinery.

HOEFER TWO-SPINDLE BORING MACHINE

A design of vertical, two-spindle drilling and boring machine, now being built by the Hoefer Mfg. Co., 120 Jackson St., Freeport, Ill., is shown in the accompanying view. As this machine is intended for boring operations requiring heavy cuts and



Hoefer Two-spindle Drilling and Boring Machine

rapid feeds, particular attention has been given in the design to the support of the tools and the provision against heavy strains. The design is self contained in that the countershaft is attached directly to the machine. This feature enables the speed changes for the spindles to be easily and rapidly made.

The heads which carry the spindles and the driving and feeding mechanism, are securely gibbed to a wide cross-rail, which, in turn, is bolted and doweled to the column. The spindles are of hammered crucible steel, and are large in diameter, to rigidly support the boring tools. They are ground, and run in interchangeable bronze bushings. The nose of each spindle is provided with a No. 5 Morse taper and a driving slot for the tools. The right-hand spindle head is stationary, being bolted and doweled to the rail, while the head

to the left is adjustable, so that the center-to-center distance between the spindles can be varied. This adjustment is effected by means of a handwheel shown at the right of the machine. Each head has its own driving belt and independent geared power feed, and is therefore self contained. The final drive to the spindle is through a worm and worm-gear of large pitch, which gives ample power to the spindle. The worms have ball thrust bearings, which are contained in the heads, thus eliminating any tendency, during a heavy boring operation, of pushing the heads out of alignment.

This machine is equipped with a gear feed mechanism, controlled by levers that are convenient to the operator. The feed variations range from 0.008 to 0.0625 inch per revolution of the spindle. These are the standard feeds regularly employed, but the feed variations can be arranged to meet individual requirements. To enable the machine to handle a wide variety of work, the table, which has a working surface of 18 by 48 inches, is given a longitudinal adjustment; this is effected by the crank shown, which operates through a rack and pinion movement. This adjustment enables the workman to set up a job at one end of the table, while the two spindles are at work on the other end. This feature adapts the machine to a wide range of work without sacrificing the accuracy or rapidity of the output.

Some of the dimensions of this machine are as follows: Minimum distance from the spindles to the table, 12 inches; maximum distance, 28 inches; minimum center-to-center distance between the spindles, 4⅝ inches; maximum distance, 12 inches; distance from the column to the center of the spindles, 12 inches; vertical feed of the spindles, 16 inches; greatest height from the floor to the top of the machine, 81 inches; net weight, 4800 pounds; and floor space required, 30 by 45 inches.

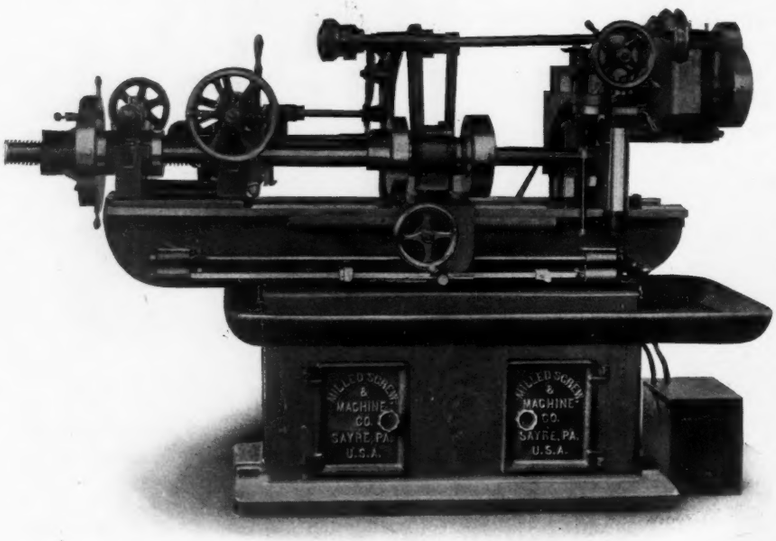


Fig. 1. Six- by Twenty-four-inch Automatic Thread Milling Machine

MILLED SCREW AND MACHINE CO.'S THREAD MILLING MACHINES

The Milled Screw and Machine Co., Sayre, Pa., is now building the heavy type of universal, automatic thread milling machines shown in the accompanying illustrations. These machines are rigidly built and particularly adapted for such work as steering-gear worms, heavy elevator worms, jack screws, roller mill, boring mill, planer and lead-screws, requiring accuracy.

The machine shown in Fig. 1 has a maximum capacity for work 6 inches in diameter and 24 inches in length, and the size shown in Fig. 2 takes work 6 inches in diameter by 48 inches in length. These machines are quite different in their construction from those built by the same company, which

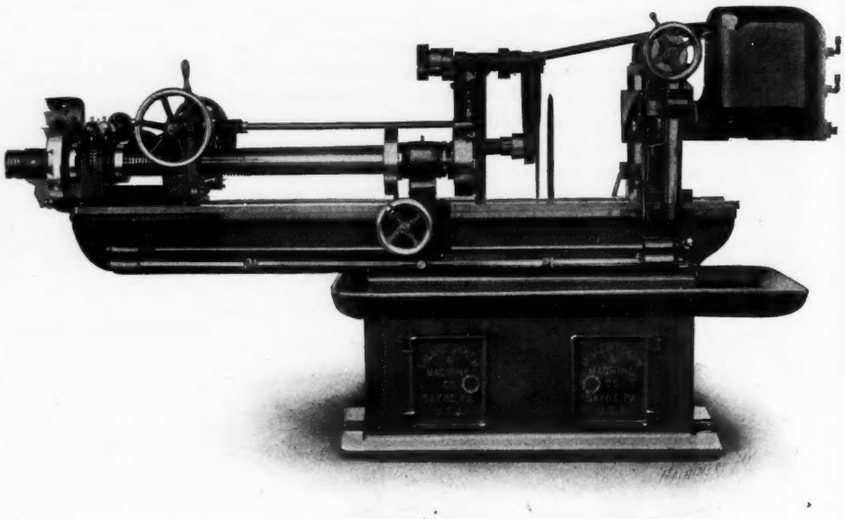


Fig. 2. Six- by Forty-eight-inch Automatic Thread Milling Machine

were illustrated in the department of New Machinery and Tools for March, 1910, though the principle of operation and general arrangement of the parts is practically the same.

In brief, the machine consists of a bed upon which is mounted a work carrying lead-screw with mechanism for imparting to it, rotary and longitudinal movements, and a spindle-driving mechanism and cutter so mounted that the latter can be set to the angular position required by the helix angle of the thread. The lead screw is of large diameter to resist torsional strains, and it is mounted directly over the center of the bed, while the blank to be threaded is gripped in a chuck that is carried on the end of the lead-screw. This lead screw is splined its entire length, and it is provided with a double worm drive which gives it a steady, direct and powerful simultaneous rotary and longitudinal motion. One of these worm-wheels is splined to the lead-screw and simply gives it a rotary movement. The second worm-wheel drives a split feed nut, seen to the extreme left in the illustrations, which imparts a longitudinal movement to the lead-screw in either direction, as desired.

Suitable change gears are interposed between the two worm shafts for changing the relative speeds of the longitudinal and rotary motions of the lead-screw, and in this way provision is made for cutting threads of different lead. The drive for the lead-screw is obtained from the main driving shaft, which is connected to a worm-shaft at the rear by a belt operating on cone pulleys, thus enabling the speed of rotation to be varied to suit the work being performed.

The machine is driven from a countershaft, or other source of power, by a belt operating on a grooved pulley, from which the power is transmitted to the cutter spindle through driving gears, as illustrated in Fig. 3, which is a detail view of the spindle head with the casing removed to show its construction. If desired, a direct motor drive can be employed. The blank to be threaded is gripped on the outside by chuck jaws at one end, and it is supported directly under the cutter while the thread is being milled, by a circular bushing bored to the exact size of the blank, so that the threaded portion is free from all strain after passing the cutter. This arrangement avoids any bending of the blank because of side pressure from

the cutter, and any tendency towards buckling because of heating is also eliminated, as there is unlimited room for longitudinal expansion. In Fig. 4 is shown a worm having a diameter of 5 inches, and a pitch of 1¾ inch, which was machined in one cut, the depth of the cut being 1 3/16 inch. By means of the coupling seen to the left of the sliding head which supports the outer end of the lead-screw, multiple threads may be cut, as this coupling enables the chuck and

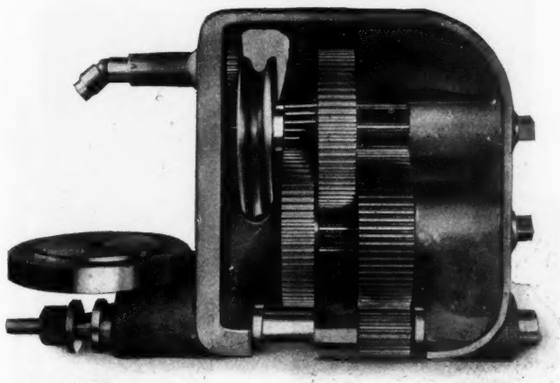


Fig. 3. Cutter-spindle Driving Mechanism

work to be accurately rotated or indexed with reference to the lead-screw.

These machines are automatic in their operation, there being positive knock-outs that may be adjusted to automatically stop the work at any predetermined point. Because of this feature, the operating requirements are very simple and the number of machines that one man can handle is only limited

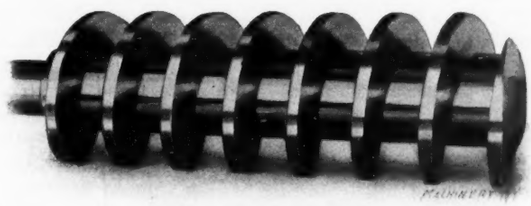


Fig. 4. Worm Machined in One Cut in an Automatic Thread Milling Machine—Diameter 5 inches

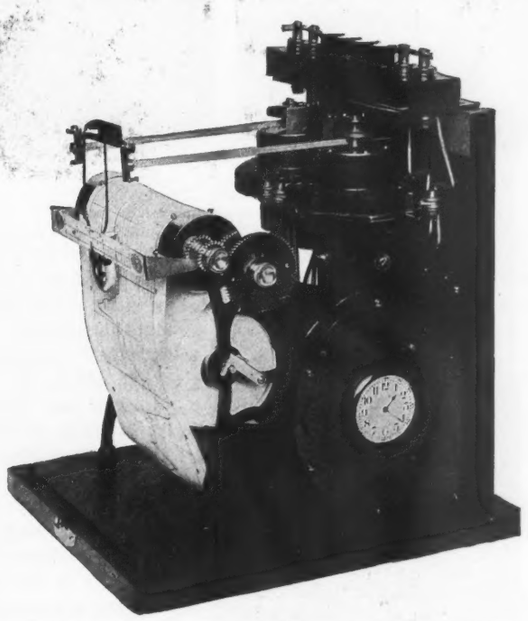
by the number of blanks he can gage and look after. In case the main belt should break, the entire machine would stop; similarly if the small belt for driving the lead-screw mechanism should break, the feed would stop, and in any event, the construction is such that there would be no damage to the work. By means of a simple attachment that can be furnished extra, if required, keyways may be cut on these machines.

PORTABLE GRAPHIC RECORDING METER

A portable type of recording meter for showing graphically on a chart the exact performance of machines in electrically-driven plants, has been developed by Messrs. R. C. Lanphier and H. W. Young of the Sangamo Electric Co., Springfield, Ill. This meter has been specially designed to withstand the rough treatment to which portable meters are usually subjected, and to give complete, accurate records which will enable the load factor and efficiency of motor-driven machines to be determined.

The measuring mechanism of this meter consists of two mercury-floated motor elements, so located as to actuate a common indicator to which is attached a recording pen that traces a line or curve on the moving chart. These measuring elements may be separately energized as in polyphase wattmeters with three-wire direct or single-phase alternating current, or they may be connected in series or parallel for use on two-wire direct-current or single-phase alternating current. The moving element is a simple metal disk or sector rigidly attached to a shaft carrying the recording pen-mounting and control springs. The disk is floated in a mercury chamber which not only serves as a conducting medium for the current to be measured, but also by the damping action of the disk passing through the mercury renders the meter indications highly dead beat. This is a very important and desirable feature when meters are measuring fluctuating loads, as it insures a true record free from false indications or "overshooting." Surrounding the moving disk there is a magnetic field having such a position, relative to the moving system or armature, that it cuts or passes through the armature field and tends to rotate the moving system. This rotative movement causes the recording pen to move across the chart against the restraining force of the control springs which tend to return the pen to the zero position. The turning force of the mercury-floated moving element is thus balanced against the restraining or coercive force of the control springs, and their point of balance, or equilibrium, is a measure of the current flowing in the measuring coils.

The record is made on a paper chart ruled with rectangular coordinates and driven by clockwork mechanism. The movement of the recording pen across the chart is proportional to the quantity measured, and the speed of the record chart is controlled by a driving clock. The recording pen is so formed as to provide an ink reservoir of sufficient capacity for several days' use. The pen point is composed of a special metal alloy insuring a clear-cut line without blurs or blots. The clock is a standard, accurate time-piece, the function of which is to drive the record paper under the recording pen at a uniform predetermined rate, synchronous with the time markings on the paper. The eight-day hand-wound type has been adopted as a standard, and the driving springs are of such size and strength that the mechanism is under a strong uniform force, giving a powerful torque and insuring a positive feed to the record paper. The driving force of the clock is transmitted to the paper roll through a suitable gear and pinion. Three inches per hour has been adopted as the standard rate of feed, but other speeds may easily be obtained by substituting gears



Graphic Recording Meter with Cover Removed to show Mechanism

and pinions having different ratios of teeth. These changes may be readily made, thus enabling the meter to be employed for special tests.

The record paper is graduated longitudinally in a set of parallel lines representing the meter calibration, the spacing being uniform with the various capacities, but of different values. At right angles to the calibration lines are parallel lines representing hours, varying in distance from each other with the particular rate of speed for which the record paper is marked. The rectangular coordinates permit of a record being easily interpolated, and the record can readily be totalized in wattmeters, by means of a planimeter.

The use of mercury suspension in a non-spillable chamber has the advantage of enabling meters to be shipped and installed without the necessity of making complicated or difficult adjustments, as it is simply necessary to fill the pen and start the driving clock. As the meters are of the direct deflection type, the use of relays, control magnets, contacts, etc., is entirely avoided. The construction adopted is also unique in that it secures a high torque or turning moment, which, in conjunction with the minimum friction value of the mercury-floated moving element, gives a ratio of "torque to weight and friction" of such value that errors due to pen friction on the chart are entirely eliminated.

Another important feature is that the moving element of the measuring system is inherently damped or rendered highly aperiodic by the dash pot action of the copper vane traveling through the mercury chamber. This very desirable and essential quality is thus secured without employing the usual auxiliary means for damping. The area of the moving system is so proportioned to the mercury-chamber area that the recording pen will not overshoot or under-register, thus insuring an accurate record on the most rapid load fluctuation.

GENERAL ELECTRIC REGULATING RHEOSTATS

Controlling devices of exceptionally rugged construction are necessary for the control of series, shunt or compound wound direct-current motors for use in machine shops or other establishments where the nature of the work is such that, ordinarily,

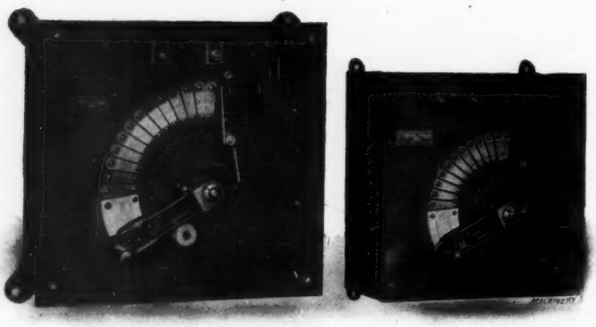


Fig. 1. Rheostats with Renewable Segments

a constant torque must be developed by the motor, the motor requiring the same current at half speed as at full speed. The regulating rheostats illustrated herewith, are designed for this service, and embody features which add to the convenience and reliability of their operation. These rheostats are the product of the General Electric Co., Schenectady, N. Y.

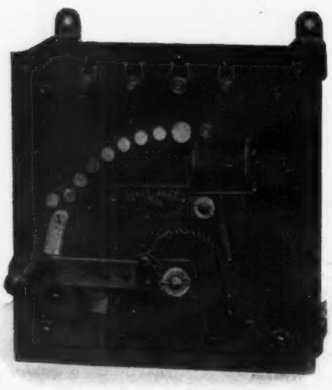


Fig. 2. Regulating Rheostat with Permanent Segments

The type illustrated in Fig. 1 is equipped with contact segments that may be easily and quickly removed. For protection against failure of voltage and the consequent danger of its immediate return, these rheostats are provided with an attachment which holds the switch arm in the running position under normal conditions of operation. If the power fails, the attachment releases the switch arm and a spring instantly returns it to the off position; the motor is then disconnected from the power circuit, and it cannot be started except in the correct way. This device is connected directly across the line in series with a resistance, and is thus independent of the current of the motor field, which varies in different motors, and it will protect any motor with which the rheostats may be used. The resistance units are of an improved design, so constructed as to be non-fragile, and thoroughly ventilated. These rheostats are designated as the CR-151.

When additional protection is required, the type known as

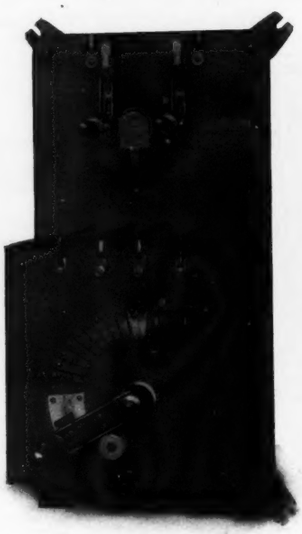


Fig. 3. Regulating Panel of the Wall Type

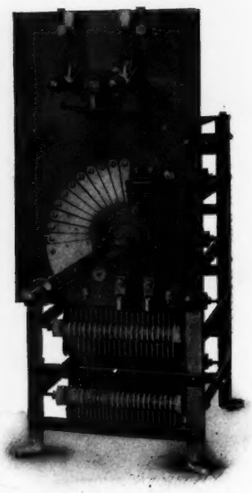


Fig. 4. Regulating Panel of the Floor Type

CR-155 should be used. They have all the features common to the type previously referred to, and in addition they are provided with a device which protects the motor in case it is too heavily loaded. For installations where the service is not so severe, the CR-152 rheostats, one of which is illustrated in Fig. 2, are used. These are similar to those illustrated in Fig. 1, with the exception that they do not have renewable segments. In the larger sizes, the circuit is made and broken on an auxiliary button, which is so designed that it can be easily renewed.

In Figs. 3 and 4, regulating panels of the wall and floor types are shown. The controllers are mounted on a slate base in connection with a double-pole circuit breaker, thus forming a very compact equipment, which may be easily installed.

MOTOR DRIVE FOR BARNES SLIDING EXTENSION GAP LATHE

The method of applying a self-contained motor drive to the 12-22-inch sliding-extension gap-lathe built by the Barnes Drill Co., 814 Chestnut St., Rockford, Ill., is illustrated herewith. This type of lathe is particularly adapted to the work of garages and general repair shops, owing to the wide range of work which it is capable of handling; and the self-contained drive adds to the convenience of the equipment where electric current is available.

Any constant-speed motor for either direct or alternating current may be used for driving, and when this type of motor is employed, eight changes of spindle speed are available. A variable-speed motor can, however, be used if desired, to increase the number of spindle speeds. The motor is belted to the driving shaft pulley as shown. On this shaft there are two reversing friction clutch gears which give both forward and reverse speeds. These gears are practically the same as those on the all-geared tapping machine built by this company, which was described in the department of New Machinery and Tools for July, 1910. As the illustration shows, power is transmitted from the driving cone at the rear to the spindle cone by means of a belt. This belt is 2 inches in width, and provision is made for keeping it to the required tension.

The starting, stopping, and reverse motion of the lathe spindle is controlled by the horizontal shifting bar shown above the lathe, which is within convenient reach. Moving this bar

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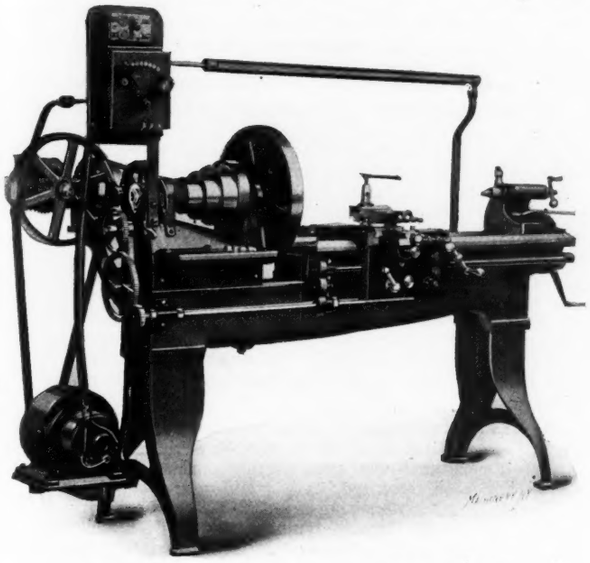
to the left gives a forward motion; a movement to the right reverses the lathe; and it can be stopped by placing the bar in a central or neutral position. The reverse speed is in the ratio of 1¾ to 1. The starting rheostat is mounted on a bracket above the headstock, as shown, and the outfit is furnished, wired, belted and ready to run as soon as the feed wires are connected.



Barnes Sliding Extension Gap Lathe with Motor Drive

This machine has power feeds for both longitudinal and cross movements, and the necessary change gears are furnished for cutting either right- or left-hand threads, ranging consecutively from 2 to 18 (including 11½ pipe thread) and by two's from 18 to 36 and by four's from 36 to 48. The bed of this machine is broad, deep, and well braced. The main and top beds are fitted together by a dovetailed construction which permits the latter to be firmly held at any point by means of clamp-bolts placed transversely through the main bed. For extending the gap, the top bed is drawn back by means of a screw and crank at the rear end. The maximum swing over the bed is 13 inches and over the carriage 8½ inches. The swing through the gap is 22½ inches. The lengths of the beds regularly furnished are 5½ and 7 ½ feet. The maximum distance between the centers with beds of this length, when closed, is, respectively, 36 and 60 inches. With the top bed extended, the maximum distance between the centers is 54 and 96 inches for the 5½- and 7½-foot beds, respectively.

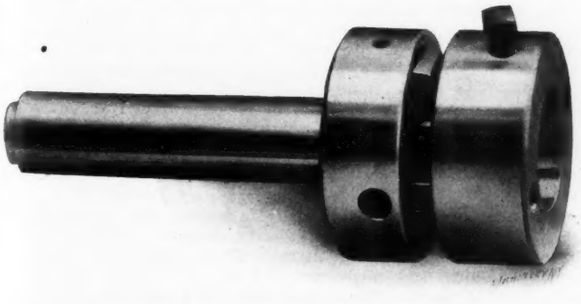


Fig. 1. Cleveland "Silent" Die-holder for Right- or Left-hand Threads

CLEVELAND "SILENT" DIE-HOLDER

An ingenious design of die-holder that has recently been brought out by the Cleveland Automatic Machine Co., Cleveland, Ohio, is illustrated in Figs. 1 and 2. This is known as the "silent" die holder, owing to the fact that the driving members do not strike or pound against each other after disengagement at the forward end of the turret travel. With some makes, the drivers strike more or less, provided the turret does not recede instantly, thereby damaging the die-holder and making an unpleasant noise. This holder can also be used for right- or left-hand threads by making a few simple changes.

As shown in the sectional view, Fig. 2, the holder has a sleeve which is gripped in the turret and a stem which fits in the sleeve. In the driving mechanism there are two pieces *A*, of the same shape, which are held in position by screws *B*. The driving pins *E*, which come in contact with parts *A* when threading, are plain pins having heads which are somewhat larger than the body and flattened on the sides. Parts *A* and *E* are held in their correct positions by a weak, piano-wire coiled spring *I*, which is just strong enough to keep the two large members of the die-holder together. After the turret has advanced to the end of its travel, and the driving points *A* and *E* are disengaged, the small springs *G* swing parts *A*, which are pivoted on screws *B*, back so that their angular ends are nearly in a straight position, or in a plane at right angles to the axis of the holder. By this movement, the ends of driving pins *E* and parts *A* clear one another, regardless of how long the turret remains in the advanced position, thereby eliminating any pounding and damaging of the parts which carry the die or tap forward. The pieces *C* have no duty to perform when the die-holder is on the threading operation, but when the spindle reverses, parts *C* drop into the slots *H* and hold the die-holder rigid while the turret recedes. These pieces are constantly held in their position, whether in the slots or otherwise, by springs *K*. The slots *H*, into which pieces *C* fit, are milled on a fairly large diameter, and this part of the mechanism is designed to last indefinitely.

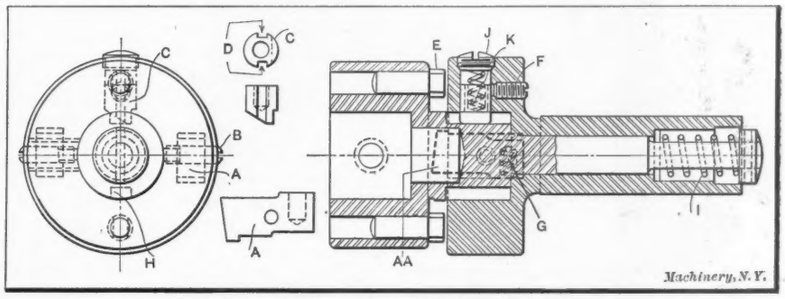


Fig. 2. Sectional View of Cleveland Die-holder

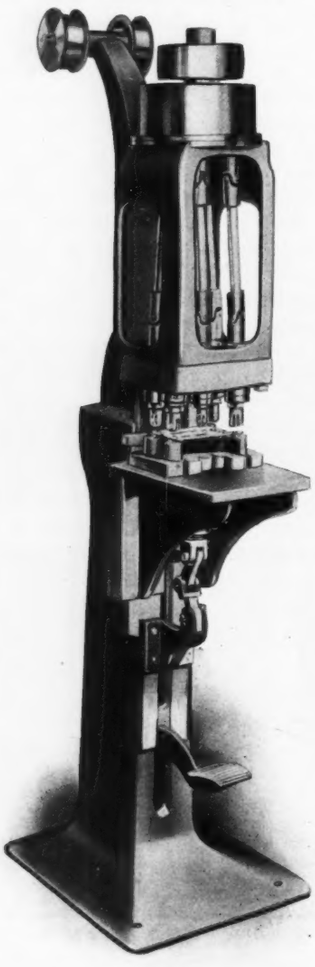
When changing the die-holder for cutting left-hand threads, the screws *B* are removed and the parts *A* are turned over so that the straight driving side is in the opposite direction in both cases. The screws *J* and *F* are also removed so that pieces *C* can be turned around to reverse the position of the driving sides. The small screws *F* fit into slots *E* and simply hold the pieces *C* in their proper position. From the foregoing, it will be seen that the necessary changes for cutting a thread of opposite hand, take but a few moments. After a long series of tests made by the company, the mechanism of this die-holder showed no perceptible wear, which speaks well for its durability.

GRANT FIVE-SPINDLE ROTATING-ROLL RIVET SPINNING MACHINES

The machine illustrated herewith is a special five-spindle noiseless, rotating-roll, rivet-spinning machine, recently brought out by the Grant Mfg. & Machine Co., 80 Silliman Ave., Bridgeport, Conn. This riveting machine differs materially from the regular line of single-spindle riveters built by this company. The table is arranged to move up and down thus bringing the work in contact with the spinning rolls through the medium of a toggle leverage arrangement. The spindles are also individually adjusted vertically to accommodate varying heights of work to be riveted.

The method of revolving the spindles from one common pulley is practically the same as that used in multiple-spindle

drills. The spiral gears which operate the spindles are enclosed in a cast-iron case and are partially immersed in oil. The gears are so arranged that a pumping action takes place while they are in motion, which draws the oil from the bottom up around the sleeve gear bearing; it is then thrown out at the top of the gears, due to the centrifugal force, and returns to the bottom of the gear case, thus lubricating all of the upper working parts in a thorough manner.



Rotating-roll Rivet-spinning Machine

It will be noted that the roll-holders and the lower part of the spindles are mounted in a solid casting which is attached to the main frame of the machine. The spindles are so located in this casting that they exactly match the location of the posts which are to be riveted, it being intended to use several of the roll-holder spindle-locating plates or castings to accommodate work of varying center distances and shapes. The plates all being interchangeable with the frame, can be quickly removed and replaced by others, owing to the fact that the lower part of the universal-joint connecting the lower part of the spindle with the upper, has a square hole in it matching the short spindle which is attached to the plate casting. This permits of its being removed and another plate and its spindles inserted which will exactly match the work it is intended for, without adjustment, in a very few minutes.

This machine was designed particularly for riveting five posts into clock frames or plates. The machine is, however, readily adapted to quite a variety of work where the parts to be riveted are not too close together as it is necessary to have the riveting spindles of sufficient size to insure ample strength.

NEW MACHINERY AND TOOLS NOTES

Mandrel: Jaeger & Sword Mfg. Co., Millbrook, N. Y. Mandrel equipped with a roller grip which holds the work in a positive manner. This mandrel is particularly adapted for such work as gear blanks, collars, bushings, etc.

Tool-room Forge: C. U. Scott, Davenport, Iowa. Forge especially designed for high heats. It is claimed for this furnace that extremely high heats can be taken on finished tools without scaling or blistering them. The size of the heating chamber is 4½ by 9 inches, and the opening measures 5 by 3 inches.

Combined Punch and Shear: Henry Pels & Co., 90 West St., New York City. Combined universal punch, splitting shear, angle and bar cutter adapted to the work of shipyards, boiler, bridge or structural shops. This machine is built in seven sizes, and it will be made to conform to any specifications which may be furnished.

Tool and Surface Grinder: Burke Machinery Co., Conneaut, Ohio. The tool and surface grinder formerly built by the XXth Century Tool Co., is now being manufactured by the Burke Machinery Co. This machine is adapted to the grinding of form and cutting-off tools for hand or automatic screw machines, and is also useful for general tool and surface grinding.

Press: Ferracute Machine Co., Bridgeton, N. J. Press particularly adapted for such work as notched armature disks. The distance between the columns is 40 inches, and the machine is equipped with a circular die-bed. The drive is sufficiently powerful to enable the use of dies having flat cutting surfaces, rather than the sheared type, as those without shear have been found preferable for armature disks.

Electric Hand Drill: United States Electrical Tool Co., 1938 West 8th St., Cincinnati, Ohio. Electric hand drill that is exceptionally light and convenient to handle, its complete weight being only 9 pounds. The motor is of the self-starting induction type and is designed for a 110- or 220-volt, 60-cycle, single-phase alternating current. The casing for the motor is made of aluminum to reduce the weight as much as possible.

Drill Press Milling Attachment: Ritter Machine Co., Sedalia, Mo. Attachment that may be applied to a drill press for cutting keyways or for end milling operations. The frame of the attachment is clamped to the spindle quill, and a bevel gear attached to the end of the spindle drives the cutter arbor through a train of gearing. The work is attached to an auxiliary table or slide that is mounted on the regular drill press table.

Recording Instrument: General Electric Co., Schenectady, N. Y. Recording instrument for obtaining information on motor-driven machines, such as the number of hours the machine has been operated, both running light and loaded, the time required for removing a finished piece of work and starting another, etc. This instrument is well designed, both electrically and mechanically, and it is adapted to permanent or temporary installation.

Tumbling Barrel: J. M. Betton, 178 Washington St., New York. Tumbling barrel in which the castings are cleaned by the action of a sand blast which is conveyed to the barrel through two pipes having nozzles which are moved mechanically across the barrels so as to cover all the articles to be cleaned. It is said that from 250 to 350 pounds of brass castings may be cleaned in this barrel in ten minutes and without defacing the surfaces of the work in any way.

Spark Plug Wrench: J. H. Williams & Co., 150 Hamilton Ave., Brooklyn, N. Y. Drop forged, steel spark-plug wrench having a box end adapted for ½-inch spark plugs, and an open end fitting a tire lug, a ⅜-inch United States Standard cap-screw, a ⅜-inch A. L. A. M. standard nut and cap-screw, and a 9/16-inch setscrew. This wrench has been designed to meet the demand for a convenient and reliable tool, around automobiles, motor boats, gasoline engines, etc.

Combined Punch and Shear: Slater, Marsden & Whittemore Co., Beloit, Wis. Combined power punch and shear built in four different sizes. The body is a single piece casting and the eccentric is cast integral with its shaft. The operating clutch is an improved positive, four-jaw type controlled by a foot lever. This tool is equipped with knives for cutting both round and flat stock, in addition to a punch and die and adjustable gage. Angle shearing attachments, and other special equipment can also be supplied.

Tool-Holder: Universal Tool Co., Jamestown, N. Y. Tool-holder especially designed for planer, shaper and boring-mill work. The body of the holder is enlarged at the working end which contains a swiveling part through which the cutter passes. This swivel may be clamped in any position, which enables the cutter to be used for either vertical or horizontal planing. A self-tightening feature causes the cutter to be held more firmly, as the pressure of the cut increases. As the cutter is located back of the holder far enough to be in line with the pin in the clapper-box, chatter is eliminated.

Reducing Presses: Standard Machinery Co., 7 Beverly St., Providence, R. I. A line of reducing presses used for drawing, broaching and reducing metal. These machines may be equipped with dial feeds, or with an automatic cam knock-out for sheet work. They have extra long ways, long bearings for the slides and ball-and-socket connections. The crank-shaft is of heavy drop-forged steel. The driving power is taken direct on the clutch and pulley, so that the balance wheel is without a belt. The equipment regularly furnished with these presses includes all the accessories ordinarily supplied with a tool of this character.

Power Presses: Leader Foundry & Machine Co., Quincy, Ill. Line of inclinable open-back power presses. The frame of the press proper is mounted in a cradle or base and it may be inclined by means of a screw and swiveling device. The frame is reinforced by tie-rods at the front, which are used only for heavy forming and embossing work. A safety clutch is provided so that the dies may be set while the flywheel is in motion. The automatic knock-out attachment is positive and does not depend upon springs for its action. The cap

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grip is designed for holding either round or square shanks rigidly and without marring them.

Automatic Shears: Kane & Roach, Niagara and Shonnard Sts., Syracuse, N. Y. Automatic shears equipped with straightener for straightening and cutting automatically strips of any desired length from sheet-metal coils. The coil, mounted on a reel, is placed in front of the machine, and the material is drawn between the straightening rolls and then cut into strips, the length of which depends upon the position of an adjustable gage which the stock strikes, thus tripping the machine and setting the shears in motion. This machine has a capacity for stock ranging in widths from 3 or 4 inches to 15 inches and with thicknesses varying from 1/8 to 5/16 inch. It can be furnished for lighter or heavier and wider work and, if desired, it can be arranged for straightening shapes other than sheets or flat stock.

Horizontal Boring, Milling, and Drilling Machine: Cleveland Machine Tool Works, Cleveland, Ohio. Horizontal boring, milling, and drilling machine driven by a three-horsepower constant-speed motor, operating at a speed of 1135 revolutions per minute. The motor is attached to the rear of the bed, and it is protected from chips and dirt by a hood. The machine has 12 speed changes, in geometrical progression; six of these are direct, while the remainder are obtained by the back gears. There are also 16 head, platen, and bar feeds obtained through positive gearing, and varying from 0.005 inch to 0.3 inch per revolution of the spindle. All feeds are reversible and a complete change in either speed or feed can be made by the manipulation of a single handle. These changes can also be made while the machine is running, without interference. Attachments, such as a revolving table, auxiliary table, boring-bars and star-feed facing-head can be supplied.

Pneumatic Grinder: Cleveland Pneumatic Tool Co., Cleveland, Ohio. Portable pneumatic grinder and casting cleaner. This grinder is controlled by twisting one of the handles, a turn to the right or left serving to start or stop the machine. The emery wheel arbor is equipped with ball bearings, and it is connected by a key directly to the main crankshaft, which is operated by four single-acting pistons that are connected in pairs to opposed throws of a double crankshaft. This grinder will drive wheels up to 6 inches in diameter with a 1½-inch face. It is adapted to grinding off fins and risers from iron and steel castings, trimming weld seams, etc. When clamped in a vise, it may be used for edging small tools. The emery wheel can be replaced by a multiple disk scaling wheel for removing rust or scale. A wire wheel brush can also be employed for cleaning castings, and buffing or polishing may be done by the use of a felt wheel.

Rifling Machine: Pratt & Whitney Co., Hartford, Conn. Piston rifling machine that will accommodate pistol barrels of any style up to 10 inches in length. Two barrels may be rifled simultaneously, and the machine is entirely automatic in its operation. The two spindles which carry the rifling rods are mounted in a head which travels longitudinally on the bed. The rotating action of the spindles, by means of which the rifling groove is given the required lead, is governed by a taper bar, the angular position of which is varied for different leads. The indexing mechanism is made to index for either 4, 5 or 6 grooves as desired, and it is entirely automatic. The rifling tools are of the hook cutter type, and they are automatically fed and withdrawn for each succeeding cut until the required depth is reached, when the feed is stopped automatically. Each machine is equipped with an oil pump for conveying the lubricant to the cutters.

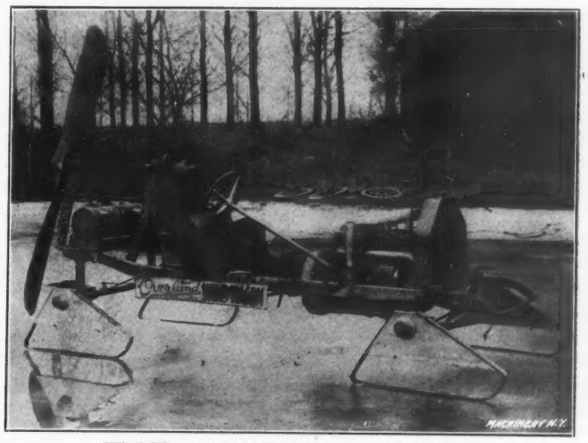
Internal Grinder: The Garvin Machine Co., Spring & Varick Sts., New York City. Hole grinder designed to give a maximum production of high-grade work. Particular attention has been given to the reduction of time required for centering and clamping work in position. By means of special jaws, bevel and spur gears may be accurately located by the pitch line. The master collet type of chuck, and a magnetic chuck with a centering plug for rapidly centering work which cannot be advantageously held in a chuck or collet, can be furnished, as well as slotted faceplates. The work-head of this machine is heavily constructed and it can be swiveled to an angle of 15 degrees for grinding taper work. This head has a cross feed of 2 3/16 inches and it is operated by a handwheel having micrometer graduations, thus enabling accurate adjustment. An adjustable diamond truing attachment is mounted on the rear of the bed, which, when not in use, may be swung back out of the way. This machine has a capacity for holes ranging in diameter from ⅞ inch to 4 inches, and for lengths up to 4 inches. Its net weight is 1200 pounds.

400-Ton Press: A. Garrison Foundry Co., Pittsburg, Pa. 400-ton double-acting drawing press, weighing about 175,000 pounds. One of the novel features of this press is the mechanism by which the blank-holding device is operated. The blank-holder is given an unusually long movement, the lift being 20 inches while the stroke of the ram is 28 inches. This gives a long interval and considerable room, for the insertion of the blank. Another advantage of the construction is that the dwell of the blank-holder is absolute; not only does all action cease but the crankshafts which lift the blank-holder, are held rigidly, being clamped in a vertical position by a latch and arm. The length of the dwell of the blank-holder is also independent of the stroke of the ram. The blank-holder carries two rods which pass down through the frames, and these rods have a cross arm through which the knockout bar passes. This arrangement for ejecting the blanks is said to be very efficient on heavy work, where blanks of unusual thickness have to be forced upward through large dies. The stroke of the knockout rod is adjustable from 20 inches down to as little as desired. The ram is raised and lowered by a small motor, mounted on it. About 100 horsepower is required for driving this machine when doing its heaviest work.

* * *

WIND WAGON ON SKATES

What is known as a "wind wagon" was first introduced to the public at the Indianapolis Motor Speedway last summer, when it raced with a Wright aeroplane driven by Walter Brookins. This machine is a stock Overland car and is driven entirely by a rapidly revolving propeller in the rear. This



"Wind Wagon," with Wheels replaced by Runners

propeller is of the aeroplane type and is eight feet in diameter. The differential is not connected with the transmission in any way, the motor being connected by a chain drive with the propeller. This machine is now equipped with runners, as shown in the accompanying illustration, and it has been driven at a high rate of speed over the snow-covered roads and ice around Indianapolis.

* * *

The formation of the Machine Tool and Engineering Association in Great Britain was referred to in the January number of MACHINERY. The organization has rapidly become a factor in the machine tool business in Great Britain, and embraces now practically all the leading machine tool builders of the United Kingdom. One of the objects of the organization is to regulate the matter of exhibitions of machinery, and the machine tool makers have decided that henceforth they will determine for themselves how, when, and where exhibitions shall be held, rather than to feel under obligations to partake in exhibitions arranged by other promoters. It has been decided to hold a large exhibition of machine tools in 1912 at Olympia. This exhibition will not, however, be confined to machine tools, but the association has decided to widen its scope so as to include every phase of engineering.

* * *

Wonderful feats in flying are becoming so common that little attention seems to be paid to even rather remarkable achievements. It seems, however, that rather too little attention has been given to the flight of Wynmalen, who, carrying a passenger, flew from Paris to Brussels and back—a total distance of nearly 350 miles—in less than 30 hours, on October 16 and 17. This flight won for the aeronaut a $20,000 prize offered by the French Automobile Club, the requirement being that the flight should be completed in less than 36 hours. The flight in one direction—Paris-Brussels—was completed in 5 hours 20 minutes.

DON'TS FOR MACHINISTS*

By H. E. WOOD†

Don't forget that a good pin gage is a very desirable and reliable tool.

Don't use a fine file for filing babbitt metal, lead, or any soft material.

Don't use a V-thread tool to cut a U. S. standard thread; they are not alike.

Don't force a drill that does not cut freely on account of incorrect grinding.

Don't hammer an unplaned steel or rough cast-iron piece down onto parallels.

Don't try to ream out much more than 1/64 inch of stock with a hand reamer.

Don't try to ream out much less than 1/32 inch of stock with a "rose reamer."

Don't hold your hand on the longitudinal carriage handle when cutting threads.

Don't spring a model, or templet out of shape when using it to lay out work from.

Don't hit the contact points of firm joint calipers on hard surfaces to adjust them.

Don't lubricate the packing of a gasoline pump with oil; common hard soap is better.

Don't fail to provide a way to get dowel pins out of work before you drive the pins in.

Don't try to cut threads on steel or wrought iron dry; use lard oil or a cutting compound.

Don't forget that a die will usually shrink more lengthwise than sidewise, in hardening.

Don't waste time trying to file with a dull file; new files are cheaper than a man's time.

Don't be reluctant about using a bastard file when possible; you can finish with a finer one.

Don't forget that gasoline is an efficient but dangerous servant for cleaning dirty parts.

Don't attempt to take a final cut on a job of threading, without a keen free cutting tool.

Don't do all the peening in one or two places if you have occasion to peen out a piston ring.

Don't think because some men call a mill file a "lathe file," that you can't do bench filing with it.

Don't forget that the side grain of a piece of sheet steel will dull tools less than the end grain.

Don't put more than two end thrusts collars on a line-shaft; under ordinary conditions, two will be sufficient.

Don't connect the ends of belts and leave the hooks poorly clinched, as the projecting ends will tear the hands.

Don't put packing under a die, or bushings in a die, and forget to provide a hole for the scrap to fall through.

Don't forget that a tank of hot soda water is a fine thing to clean dirty work with; ask for it and get it if you can.

Don't use rubber in any place on a machine where oil will get at it; the oil will soon eat the life out of the rubber.

Don't let brass or copper be exposed to ammonia in an ice machine, for the ammonia will eat it as acid eats zinc.

Don't neglect for a minute reporting the line-shaft in case you notice a coupling working loose, or a key working out.

Don't put up cord belt shifters and leave the ends hanging near belts, without having weights on the end of the cord.

Don't forget that you should have a rack in front of your vise to keep your files in, for it ruins them to hit together.

Don't run a chuck or faceplate up to the shoulder suddenly; it strains the spindle and threads and makes removal difficult.

Don't forget that it saves time and worry to have the tool-room checks stamped with the numbers on both sides of them.

Don't continue using a lathe in which the tail-center does not eject itself; if it is too short, insert a pin into the back end.

Don't forget that a crossed belt may be made to run to one side, or to the center of the pulleys, by crossing it different ways.

Don't forget that common hard soap makes a splendid thing to temper a scratch awl in; it needs no drawing after this plunge.

Don't screw your lathe centers up too tight on any kind of work, as it is sufficient to have the slack all taken up, and no more.

Don't loosen the screws too much, at the time you raise or lower the shaper knee; it allows a chance for chips to get behind it.

Don't clean out a tapped hole in a hardened piece of work by running a tap into it, even if you can scratch the piece with a file.

Don't throw a file-cleaning brush in among heavy pieces of scrap, etc.; the wire bristles need protection just as much as the file beard does.

Don't fail to put a little bees-wax, or Albany grease, or some other heavy grease on the bench draw-slides; it saves both money and energy.

Don't forget that in an emergency (when you have no nut arbor) you can screw two nuts on a tap and put them in a lathe and face them.

Don't slide sheets of copper, brass, aluminum, or any soft material along on a pile of the same material without placing a board under them.

Don't forget that the reason pulleys are made larger in the center of the face than at the edge is because the belt runs to the highest point.

Don't be in too much of a rush or nervous when calipering a piece of work, as that is one job at which you must be deliberate to insure accuracy.

Don't fail to pick up all washers, nuts, odd bolts, straps, scrap pieces of brass, etc., and put them where they can be found when wanted for use.

Don't caliper a piece of work in a grinding machine when the emery wheels are running, as even the slightest vibration destroys the sense of touch.

Don't forget that if your largest lathe dog has too small a mouth to bite the job, you can grip it by using two straps, of most any kind, bolted together.

Don't leave defective goods lying around the shop, in windows, in corners and nooks, or on ledges; it is better to consign them at once to the scrap heap.

Don't screw a tool-post screw any tighter than is absolutely necessary; many mechanics have a false idea as to how tight a lathe tool should be to do its work.

Don't throw odd-sized bolts into a bin among the standard bolts; it is better to have a special bin for all odd bolts and nuts, or to put them in the scrap box.

Don't wear overalls with rags on them; if you can't afford to buy new ones have the old ones patched; patches are no disgrace, but rags are dangerous in many ways.

Don't forget that if you tell the emery wheel or carborundum wheel manufacturers what class of work you are to do, they will advise you rightly about what wheels to use.

Don't use a large tap wrench on small taps or reamers, even if you can screw the jaw down so that the hole fits the shank, as the slender tools are liable to be broken.

Don't use a lathe carriage any length of time in one place and then start and run it a long distance, without cleaning off the shears and adding a little oil before you start on the trip.

Don't attempt to cut a T-slot on a shaper or planer without raising your tool up over the work on each return stroke, unless the clapper-block is bolted down so that the tool cannot rise.

Don't expose the fine or delicate cutting edge of any tool to the hottest place in the fire; you should heat the heavy parts first if possible and let the heat run out to the thin or cutting edges.

Don't plane down the side of a piece of work on a planer or shaper without shifting the clapper-block over to one side, thus causing the tool to swing away from the surface you are cutting, and not ride over it.

Don't grow envious and start "knocking" a man when you know he is getting more wages than you are; rather try to make yourself as valuable to the company as he is and thus get an increase in your own wages.

* For Don'ts previously published in MACHINERY, see "Don'ts for Electricians," October, 1910, and accompanying references.

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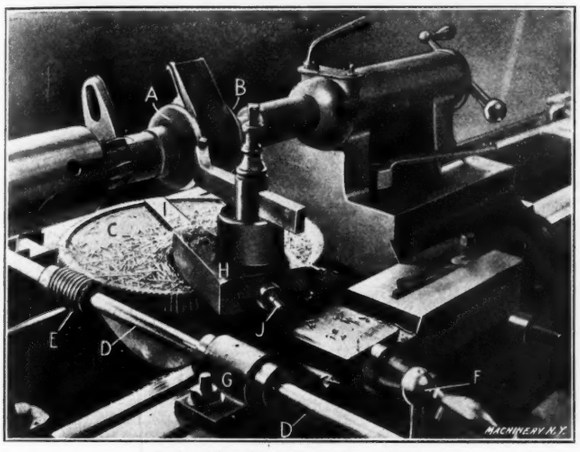
LATHE ATTACHMENT FOR TURNING SPHERICAL SEGMENTS

By ETHAN VIALL*

The turning of the small balls on the ends of ball-cranks, or other similar jobs, is comparatively easy and may be done in several ways with nothing more than forming tools of either circular or tube-like cutting section, but when it comes to doing spherical turning on large pieces of work where the cut is interrupted in the manner shown in the accompanying engraving and in which considerable tough metal has to be removed, a simple forming tool is not practicable for a number of reasons; and a specially designed fixture is best if more than a few are to be machined. The piece shown being turned is part of the ball-and-socket section of a case for the shaft drive on an automobile made by the Nordyke & Marmon Co., Indianapolis, Ind., and it is turned spherical only on the surfaces indicated by the points *A* and *B*. As the engraving plainly shows, the fixture used is attached to the regular tool carriage of the lathe, only the cross-slide being removed. Circular motion is imparted to the large worm gear *C*, through the shaft and worm *D* and *E*, by



Ball-cutting Attachment for a Lathe

turning the hand crank at *F*. The shaft *D* is attached to the tool carriage by two easily removed brackets or boxes which are bolted to the T-slots at the front and rear, one bracket being shown at *G*. Adjustment of the cutting tool is made possible by having the toolpost and block *H*, set on a cross-slide *I* and moved in or out by the screw *J*, though similar results to a limited extent may be obtained by setting the tool so as to project from the toolpost to a greater or less degree as desired.

The applicability of this form of attachment to various spherical turning jobs of all kinds and sizes will be at once grasped by those having such work to do.

* * *

A copy of a monthly magazine published eleven years ago containing a leading article that recorded American progress in automobiles to date, was lately brought to our attention. It was illustrated with several halftones showing the prevalent types of self-propelled vehicles of the period. The change that has taken place since is astonishing. The bicycle-type wheel has disappeared; the short body and the other buggy or horse-drawn vehicle characteristics also. The automobile was in a most unsatisfactory state so long as it followed the conventional lines of its progenitor—the horse-drawn vehicle. The logical position of the engine was found by the French designers to be directly in front where it is get-at-able, where the radiator is most advantageously located and where the engine hood gives a characteristic to the lines of the machine as a whole quite in keeping with its purpose. Moreover the forward position of the power plant made necessary the long wheel base which is advantageous in many ways. American inventors had located the engine in almost every other position, but with poor success.

* Address: 131 Mills Ave., Hartwell, Ohio.

EDWARD DANIEL MEIER

Edward Daniel Meier, who was elected president of the American Society of Mechanical Engineers at the December meeting, was born of German parentage in St. Louis, May 30, 1841. After a preliminary education in the country schools, he entered the Washington University of St. Louis, where he spent the years from 1856 to 1858. During the four following years, he was educated at the Royal Polytechnic College, Hanover, Germany, and returned to the United States in 1862, beginning his engineering career at the Mason Locomotive Works at Taunton, Mass. In the following year, however, he left the employ of this firm to enlist as a volunteer in the Union Army, and remained in service until the close of the war in 1865. After the war he immediately turned his attention to peaceful pursuits, but the military spirit continued active in him, for in 1877 he organized the first company of emergency militia in St. Louis, and he became afterwards a colonel, and was finally put in command of the entire state militia. The appointment of brigadier general was offered to him, but he declined it, and soon afterwards resigned from active service. His civil career has been no less distinguished than his military achievements. Immediately after the war he spent a year as machinist and draftsman in the Rogers Locomotive Works, at Paterson, N. J., and from 1867 to 1870 he was assistant general superintendent, and later superintendent of machinery for the Kansas Pacific Railway. In the '70's he was engaged as consulting mechanical engineer in the designing and building of machinery of various kinds. In 1882, Col. Meier began developing the well-known Heine type of water-tube boilers, and from 1885 to the present time he has been president and chief engineer of the Heine Safety Boiler Co. Practically all the advances and improvements that have been made in the past twenty years in the legal requirements of boiler material have been made through the suggestions and under the advice of Col. Meier and his associates. He has also been interested in several other mechanical devices which he has designed or perfected. His association with the American Society of Mechanical Engineers dates back to the first years of the existence of the Society, and he has served in an official capacity in that body since 1895, when for three years he was one of the managers. He was also vice-president from 1898 to 1900, and from 1909 to 1910.

* * *

In the article entitled "A Micrometer Stop for the Lathe Carriage," published in the January issue of MACHINERY, it was stated that the scale *H* shown in the illustration accompanying that article is graduated into one-hundredths of an inch. Instead it should have read that the scale is divided into twentieths of an inch.

PERSONALS

Foster Bartlett has been appointed foreman of the foundry of the New Home Sewing Machine Co., at Orange, Mass.

Walter Leonard of Athol, Mass., has taken the position of master mechanic for the Union Mfg. & Drop Forge Co., Providence, R. I.

Ethan Viall has resigned as associate editor of MACHINERY and is now connected with the *American Machinist* in a similar capacity.

J. F. Barr, formerly Detroit manager for Manning, Maxwell & Moore, Inc., has joined forces with the Gear Grinding Machine Co., Detroit, Mich.

F. P. Huston, sales manager of the Kempsmith Mfg. Co., Milwaukee, Wis., sailed in December for an extended trip abroad in the interests of his company.

William H. Hooper, for the past nine years foundry superintendent for the New Home Sewing Machine Co., Orange, Mass., has resigned his position.

William Hadley, for the past four years general foreman of the machine department of the Hendee Mfg. Co., Springfield, Mass., has resigned his position.

George W. McIntyre, representing the Monarch Valve Co., Springfield, Mass., is taking a six weeks' trip through France, looking after the interests of the company in that territory.

E. F. Lake, for a number of years associate editor of the *American Machinist*, has resigned, and will, for a time, contribute articles on metallurgical subjects to the technical press generally.

H. B. Layman, formerly with the Packard Co., and for the past year president and general manager of the Brightwood Motor Mfg. Co., Springfield, Mass., has withdrawn from that company.

W. L. Schellenbach, formerly with the John B. Morris Machine Tool Co., Cincinnati, Ohio, has taken the position of chief engineer with the Lodge & Shipley Machine Tool Co., of Cincinnati.

Cecil H. Taylor, formerly chief engineer of the Hudson Motor Car Co., Detroit, Mich., has taken a position in the engineering department of the Everett-Metzger-Flanders Co., in the same city.

E. J. Stone, Springfield, Mass., has resigned as chief draftsman and mechanical engineer of the Chapman Valve Mfg. Co. to take the position of general manager for the Brightwood Motor Mfg. Co., of Springfield.

W. A. Davidson, for the past six months draftsman for the Parker Transmission & Appliance Co., Springfield, Mass., has resigned and will return to his former position with the Colburn Automobile Co., Denver, Colo., as designing and head draftsman.

Walter Loring Webb and James M. Kennedy, well-known in the engineering world, have been added to the organization of the engineering firm of Dodge, Day & Zimmerman of Philadelphia, Pa. Mr. Webb has a reputation as the author of several engineering text-books.

E. C. Hosmer, for the past three years employed by the Crucible Steel Co. of America, has resigned and taken a position with Denman & Davies, steel and iron merchants, New York. Mr. Hosmer will cover the Connecticut and Massachusetts territory, his headquarters being at Springfield, Mass.

F. O. Hoagland, who was recently appointed acting works manager of the Remington Arms Co., Ilion, N. Y., at the time when C. C. Tyler, formerly works manager, was appointed general manager of works for the Remington Arms Co., Ilion, N. Y., and the Union Metallic Cartridge Co., Bridgeport, Conn., has now been appointed works manager of the Union Metallic Cartridge Co.

W. S. Chase and P. E. Ryan of the National-Acme Mfg. Co., Cleveland, Ohio, sailed for England January 14, for the purpose of establishing a sales branch in Great Britain. This branch will handle not only the regular Acme automatic multiple-spindle machines, but special machinery for second operation work, etc., as well. Messrs. Chase and Ryan will also spend some time traveling on the Continent in the interests of their company.

* * *

The latest Government report of the number of railroad employes puts the total number for the country at 1,672,074. Of this number approximately 665,000, or 40 per cent., are employed on railroads which have inaugurated pension systems. The leading railroads having inaugurated pension systems are the New York Central, the Rock Island, the Pennsylvania, the Buffalo, Rochester & Pittsburg, the Chicago & Northwestern, the Illinois Central, the Santa Fe, the Union Pacific, the Southern Pacific, the Lackawanna, the Baltimore & Ohio, the Atlantic Coast Line, the Reading, and the Jersey Central.

Charles Hill Morgan

OBITUARIES

Clayton S. Mattison, treasurer and superintendent of the Eagle Square Co., South Shaftsbury, Vt., died in January, aged forty-one years.

Charles Nicholson, salesman for the Carborundum Co., Niagara Falls, N. Y., died at his home in Philadelphia, December 18, aged fifty-nine years.

Jay E. Spaulding, president and treasurer of the New England Pin Co., Winsted, Conn., died at his home on January 6, aged sixty-four years.

Alpheus W. Rice, for the past forty-five years an employe at the Smith & Wesson Works in Springfield, Mass., died at his home in that city December 3, aged seventy years.

Henry Grant Thompson, secretary and treasurer of the Henry G. Thompson & Son Co., New Haven, Conn., died recently at Paris, France, after an operation for appendicitis, aged fifty-seven years.

Fred B. Childs of Spokane, Wash., who was master mechanic of the Northern Pacific Railroad Co.'s shops, was last month stricken with apoplexy and died while on board a train in Montana. He was forty-eight years of age.

James Sadler, one of the first steel makers in the United States, and for many years in charge of the Farist & Windsor Steel Co. at Windsor Locks, Conn., which company furnished much steel for the government during the Civil War, died at Springfield, Mass., January 4, aged seventy-six years.

CHARLES HILL MORGAN

On January 10, Charles Hill Morgan, president of the Morgan Spring Co. and the Morgan Construction Co., of Worcester, Mass., died at his home at 28 Catharine St., of that city. Mr. Morgan was born January 8, 1831, and was thus eighty years old at the time of his death. At the age of fifteen he entered the machine shop of his uncle, Mr. J. B. Parker, of Clinton, Mass., as an apprentice; during this time he also studied mechanical drawing at night, after twelve hours' work in the shop. When twenty-one he was put in charge of the Clinton mills dye house, and devoted himself with great zeal to the study of chemistry. He was then for some time draftsman for the Lawrence Machine Co., and from 1855 to 1860 was employed in the same capacity by the well-known inventor and manufacturer, Erastus B. Bigelow. In 1860 Mr. Morgan formed a partnership with his brother, Francis H. Morgan, and was for some years engaged in the manufacture of paper bags in Philadelphia. He at this time developed machinery which put paper-bag making in the United States on a commercial basis. In 1864 he entered into the employ of the Washburn & Moen Mfg. Co., of Worcester, Mass., as general superintendent—a position which he held for twenty-three years. In this capacity he traveled extensively in Europe for the purpose of studying wire manufacture abroad. For eleven years he was one of the directors of the company. Mr. Morgan has been prominently identified with the development of the continuous rolling mill and with spring making. In 1881 he founded the Morgan Spring Co. for the manufacture of springs, and was a pioneer in this line of business. In 1891 the Morgan Construction Co., which devoted itself to the making of rolling mills and wire drawing machinery, was founded. In 1852 Mr. Morgan married Harriet T. Plympton of Shrewsbury, Mass., who died a few years later leaving a son. In 1863 he married Rebecca A. Beagary who, with two sons and two daughters, survives him.

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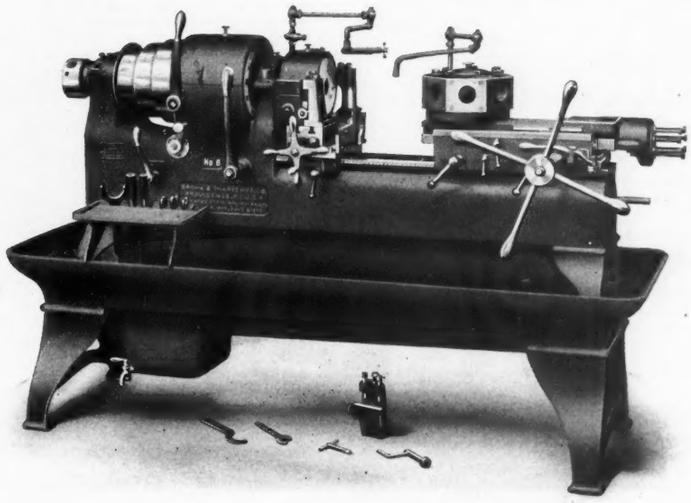
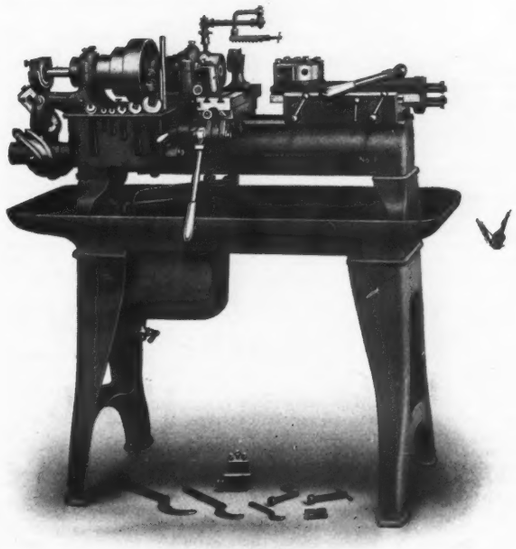
These machines are adapted for the rapid production of duplicate parts in small lots.



B. & S. Wire Feed Screw Machines

Unless the volume of any one kind of work in a shop is sufficient to warrant the installation of automatic machines, the wire feed type is the most economical to employ. Because they are adapted for such work, they embody many conveniences to aid in setting up and operating.

A glance at the sizes of the machines in the line will emphasize their range. They are as follows:



No. 0 takes stock 3/8" diameter; turns to 2¼" length.

No. 1 takes stock 5/8" diameter; turns to 3" length.

No. 2 takes stock 7/8" diameter; turns to 4" length.

No. 4 takes stock 1¼" diameter; turns to 8".

No. 6 takes stock 1½" diameter; turns to 10".

See our Catalogue for detailed descriptions. Sent on request.

BROWN & SHARPE MFG. CO.

Providence, R. I., U. S. A.

COMING EVENTS

January 28-February 11.—Tenth Annual National Automobile Show under the auspices of the National Association of Automobile Manufacturers, Inc., in the Coliseum and Coliseum Annex, Chicago. S. A. Mills, manager, New Southern Hotel, Chicago.

February 9.—Monthly meeting of the Institute of Operating Engineers, in the Engineering Societies Bldg., 29 W. 39th St., New York City.

June 14-16.—Annual Convention of the American Railway Master Mechanics' Association, Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Building, Chicago.

June 14-21.—Annual convention of the Railway Supply Manufacturers' Association, in conjunction with the American Railway Master Mechanics', and Master Car Builders' Associations, Atlantic City, N. J. J. D. Conway, secretary, 2135 Oliver Bldg., Pittsburg, Pa.

June 19-21.—Annual convention of the Master Car Builders' Association, Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago.

SOCIETIES AND COLLEGES

AMERICAN SOCIETY OF ENGINEER DRAFTSMEN, 116 Nassau St., New York. Prospectus of the aim and scope of this new national organization for draftsmen.

NEW YORK ELECTRICAL CREDIT ASSOCIATION, 80 Wall St., at its meeting in December elected W. B. Wallace to succeed P. M. Haight as president, and U. S. Kolby and F. A. Wurzbach as the new directors. The hold-over directors are: John H. Dale, W. H. Roberts, W. C. Hall, B. H. Ellis, and W. B. Wallace. A. L. Miller was re-elected representative on the board of managers. The following concerns were also elected members of the association: Hunter Fan & Motor Co., Fulton, N. Y.; New England Electric Supply Co., Hartford, Conn.; Westinghouse Electric & Mfg. Co., Pittsburg, Pa.; Penn Yan Flexible Conduit Co., Penn Yan, N. Y.; and Richard W. Osland, New York City.

SHEFFIELD SCIENTIFIC SCHOOL, Yale University, New Haven, Conn., is having a new mechanical engineering laboratory built, the funds for which were supplied to the Sheffield trustees by two graduates, G. G. and W. S. Mason. Work on the building is progressing, and it should be completed early this summer. The building, which has three floors above the basement, will be 85 feet wide by 200 feet long, especially adapted for its purpose. In the building no provision has been made for recitation or drawing-rooms, the entire space being devoted to instruction and experimental work for undergraduates and for research work along engineering lines for graduate students and special investigators. The main floor of the laboratory will contain the larger pieces of the equipment, and will be served by a 40-foot electric crane traveling its full length.

NEW BOOKS AND PAMPHLETS

ANNUAL REPORT OF THE INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. 170 pages, 6 x 9 inches. C. R. George, secretary, Houston, Texas.

ANNUAL REPORT OF THE STATISTICS OF EXPRESS COMPANIES IN THE UNITED STATES. 82 pages, 8 x 10½ inches. Prepared by the Bureau of Statistics and Accounts, Washington, D. C.

PROCEEDINGS OF THE THIRTIETH ANNUAL CONVENTION OF THE AMERICAN WATER WORKS ASSOCIATION, held at New Orleans, April 26-30, 1910. 292 pages, 6 x 9 inches. John M. Diven, secretary, Charleston, S. C.

WASHING AND COKING TESTS OF COAL. By A. W. Belden, G. R. Delamater, J. W. Groves, and K. M. Way. 62 pages, 6 x 9 inches. Illustrated. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Bulletin No. 5.

NORTH DAKOTA LIGNITE AS A FUEL FOR POWER-PLANT BOILERS. By D. T. Randall and Henry Kreisinger. 42 pages, 6 x 9 inches. Illustrated. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Bulletin No. 2.

TEST OF AN "E2A" LOCOMOTIVE ON THE PENNSYLVANIA RAILROAD COMPANY'S TEST PLANT, BULLETIN NO. 5. 115 pages, 6 x 9 inches. Published by the Pennsylvania Railroad Co., Altoona, Pa.

This bulletin contains detailed information of the tests on a class "E2a" locomotive of the two-cylinder simple Atlantic type, performed at the locomotive testing plant at Altoona, Pa. It had been purposed to make this test at the plant when installed at St. Louis, but lack of time prevented this from being done. This bulletin is to be considered supplementary to the publication issued after the close of the Louisiana Purchase Exposition, and gives the means of comparing the performance of the simple-cylinder locomotive with that of the four-cylinder compound locomotive, the latter of which was tested at that time.

FREIGHT TRAIN RESISTANCE. By Edward C. Schmidt. 152 pages, 6 x 9 inches. 50 illustrations, 69 tables. Published by the University of Illinois, Urbana, Ill., as Bulletin No. 43.

This bulletin presents the results of tests upon thirty-two freight trains in regular service, in order to determine their train resistance. These tests were undertaken to study the effects upon train resistance of both speed, and the average weight of cars composing the trains. The results show the usually-accepted influence of speed upon resistance, and they reveal a still greater influence of average car weight in affecting changes in resistance. For trains composed of cars weighing 15 tons on the average, the resistance is shown to vary from 7½ pounds per ton at 5 miles per hour to 13½ pounds per ton at 40 miles per hour; while for trains composed of cars weighing 75 tons, the resistance is found to vary from 3 pounds per ton at 5 miles per hour to 5½ pounds per ton at 40 miles per hour. The whole treatment of the subject is taken up in a masterful way, and represents a tremendous amount of work on the part of the experimenters.

SECURING EFFICIENCY IN RAILROAD WORK. By Harrington Emerson. 38 pages, 5 x 8 inches. Published by The Emerson Co., 30 Church St., New York. Price, 25 cents.

This booklet is a reprint of a lecture delivered before the Graduate School of Business Administration of Howard University, November 16, 1910, and in brief form gives the substance of the efficiency theories being advanced by Mr. Emerson. In support of these theories the brochure goes on to explain the wonderful savings effected on the Santa Fe, by the application of the principles laid down by Mr. Emerson. From data given, marked advances were made in every direction by this road on the introduction of this new system. Particular emphasis is given throughout the book to the geometrically increasing efficiency due to arithmetical improvements in each of several dependent departments. On this basis, some wonderful inferences are drawn. Another striking feature of the book, is the prominence given to the bonus system of remuneration. Mr. Emerson has great faith in its efficiency in solving the labor problem.

PRACTICAL ALLOYING. By John F. Buchanan. 205 pages. Illustrated. Published by The Penton Publishing Co., Cleveland, Ohio. Price, $2.50.

This book, by the well-known writer in foundry papers, has just made its appearance from the press. Mr. Buchanan has a high reputation as an authority on all kinds of alloys, with particular reference to their practical working. Without doubt this is one of the most complete and comprehensive treatises on alloying that has ever been published. The treatment of the subject is extremely interesting, the development of the casting industry being followed from the earliest times—Aaron's golden calf—culminating in a full, clear exposition of present-day practice. One of the strong features of the book is the number of practical tables contained, of which there are some thirty-three in the text, and in addition a number more in a concluding appendix. This feature, in itself, makes the book of high value. The chapters are as follows: Metal Refining—Ancient and Modern; History and Peculiarities of Alloys; Properties of Alloys; Some Difficulties of Alloying; Method of Making Alloys; Color of Alloys; Notation of Alloys; Standard Alloys, Foundry Mixtures; White Metals; Solders, Novelty Metals, etc.; Fluxes for Alloys; Gates and Risers for Alloys; About Crucibles and Testing Alloys.

THE SLIDE RULE. By Frank C. Hinckley and William W. Ramsay. 104 pages, 4¼ x 6¾ inches. Published by the Engineering Text-Book Co., Boston, Mass. Price: cloth, $1.25; flexible leather, $1.75.

This book is primarily written for men of limited mathematical training, with special reference to the needs of boiler inspectors, engineers and mechanics. It contains some illustrative examples showing the adaptability of the slide rule to problems in steam engineering. The book is the outcome of the experience of the authors and their friends, who encountered numerous difficulties in the mastering of the slide rule from the usual instruction book, and who therefore realized that a text-book written in plain English would tend to raise the veil of mystery and render its use possible to other than higher mathematicians. Contrary to customary methods, the book is unillustrated, it being believed that the only satisfactory method of instruction is by the use of the actual instrument. Chapters are as follows: The Rule; Finding Numbers on the Slide Rule; Multiplication; Division; Decimal Equivalents; Circumferences of Circles; Upper Scales and Square Roots and Squares; Areas of Circles; Cube Roots and Cubes; Logarithms; Table of Natural Sines; Table of Natural Tangents; Inverted Slide; Millimeter Scale; Position of Decimal Point; Adaptability of the Slide Rule; Principle of the Slide Rule.

SCIENTIFIC AMERICAN CYCLOPEDIA OF FORMULAS. By Albert A. Hopkins. 1077 pages, 6 x 9 inches. Illustrated. Published by Munn & Co., Inc., New York.

Twenty years ago the first volume of this book was published. Since that time, however, the world has rapidly advanced and each year a vast amount of technical literature has accumulated; therefore, instead of attempting to make any drastic revision of this book, it was deemed advisable to recompile and rewrite the entire book. This work required the constant attention of a staff of experts and professional indexers for a period of two years. The old book was thrown out in its entirety, only about 30 per cent of its formulas being retained. The others were derived from entirely new sources, chief among which is the *Scientific American*, followed by the various American and foreign drug and technical journals, of which practically all have been laid under contribution. While the present volume contains about 15,000 formulas, over 150,000 formulas still remain on file, so that only about one in ten of these were used. The twenty-seven chapters are divided as follows: Accidents and Emergencies; Agriculture; Alloys and Amalgams; Art and Artists' Materials; Beverages; Cements, Glues, Pastes, Mucilages; Cleansing, Bleaching, Renovating; Coloring of Metals; Dyeing; Electrometallurgy and Hot and Cold Coating of Metals; Glass; Heat Treatment of Metals, Annealing, Brazing, etc.; Household Formulas; Ice Cream, Confectionery and Chewing Gum; Insecticides and Extermination of Vermin; Lapidary Art, Artificing in Ivory, Bone, etc.; Leather; Lubricants; Paints, Varnishes, Bronzing, Lacquers, etc.; Photography; Preserving and Canning, Condiments, etc.; Rubber; Soap and Candles; Soldering; Toilet Preparations and Perfumes; Waterproofing and Fireproofing; Writing Materials. The index is especially good, great care having been taken in its compilation.

ELEMENTS OF ELECTRICITY FOR TECHNICAL STUDENTS. By W. H. Timbie. 556 pages, 5½ x 7½ inches. 415 illustrations. Published by John Wiley & Sons, New York. Price $2, net.

The author, who is instructor in industrial electricity at the School of Science and Technology, Pratt Institute, Brooklyn, N. Y., has primarily intended this book to meet the needs of young men who desire to follow an occupation connected with the electrical industries. He has aimed, in the preparation of the book, to include an adequate amount of information concerning electrical laws; to apply the information contained to actual practice, and not to abstract theories; to provide sufficient practice by a great number of concrete practical examples; and to eliminate history and general theory, and present only those facts and principles which the student needs to know, and to know well, in order to obtain a general conception of the principles and practice of electricity. For this reason the book does not enter into details of construction of a great number of different devices, as matter of this kind quickly becomes obsolete and is of comparatively little value for the student to acquire while at school. Knowledge of this kind is much more quickly and satisfactorily obtained in the actual practice into which he will enter later. In a comparatively short space, however, the general principles of the different phases of electrical engineering are well covered, and a novel departure in technical book-making, consisting of a summary of the contents of each chapter at the end of the chapter, has been introduced. This summary is an excellent idea. It would greatly enhance the value of all engineering textbooks if they were provided with a concluding paragraph to each chapter giving a general idea of the subject matter treated, and the main conclusions. In fact, the summary in the book under review might even have been made somewhat more extensive without fear of repeating too much of what had already been said in the more thorough treatment of the subject in the chapter itself. A great number of numerical examples selected from practice are also included. The book gives evidence of having been carefully prepared, although some inaccuracies seem to be almost unavoidable in engineering book-making. For example, on page 383 it is stated that the efficiency of the Moore tube light compares favorably with that of the best metal filament incandescent lamps. In the summary of the same chapter on page 385 it is stated that the light is of about the efficiency of carbon filament lamps. As the efficiency of carbon filament lamps is only about one-half of that of metallic filament lamps, the student may be somewhat puzzled. We are sure, however, that a book of this type will see a second edition, giving an opportunity for correcting small defects of this kind. The contents by chapters are as follows: Magnets and Magnetism; Electromagnets; Ohm's Law; Power Measurement; Measurement of Resis-

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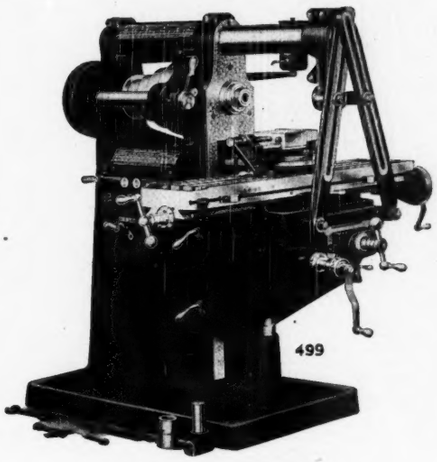
The No. 2 Cone Driven Cincinnati Miller



The No. 2 Plain

Our Cone Type Millers have not been forced off the market by single Pulley Machines. And they will not be. We are making and selling more of them than ever before. We are able to do this because we keep our design ahead of all others.

The illustrations show the No. 2. It has the manufacturers' standard range—

Plain—28″ x 8″ x 19″
Universal—25″ x 8″ x 18″

It can be supplied with power feed in one, two or three directions.

We call especial attention to the following features in its design:

The COLUMN is a complete box of rectangular form.

The FEED MECHANISM is a single unit assembled by men who are specialists on this work.

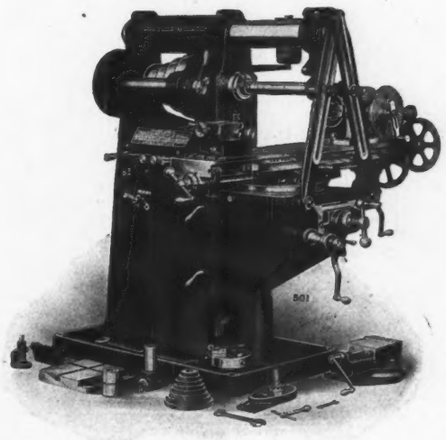
When in place, it is an integral part of the machine.

It is high above the floor. The operator need not stoop to reach the levers.

The feed changes may be made within the practical limits of milling while taking a cut without inconvenience, or injury to the gears, because they are all hardened and run at moderate speeds.

The feed index is direct reading. It is the simplest index used on any machine tool.

All these features, make this type the ideal machine for manufacturing small parts, and for Tool Room use.



The No. 2 Universal

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The Cincinnati Milling Machine Co., Cincinnati, O., U.S.A.

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tance; Magnetic Field Due to a Current; The Generator; The Motor; Inductance; Capacity; Electrochemistry; Photometry and Electric Illumination; Electrical Measuring Instruments; and Alternating Currents.

CATALOGUES AND CIRCULARS

PATTERSON TOOL & SUPPLY CO., Dayton, Ohio, and Indianapolis, Ind. Leaflet of emery grinders.

BUFFALO STEAM PUMP CO., Buffalo, N. Y. Illustrated folder of the company's Class B centrifugal pumps.

WALTON CO., Hartford, Conn. Small leaflet listing various tap extractors manufactured by this concern.

KEUFFEL & ESSER CO., Hoboken, N. J. A neat New Year's wall hanger representing an engineers' camp in the Klondike.

W. S. ROCKWELL CO., Hudson Terminal Bldg., New York. Catalogue No. 12 devoted to the Rockwell stationary crucible melting furnace.

BAUSH MACHINE TOOL CO., 200 Wason Ave., Springfield, Mass. Copy of the house organ, *The Drill*, published at intervals, and descriptive of the Baush drills.

WINNIPEG DEVELOPMENT AND INDUSTRIAL BUREAU, Winnipeg, Canada. Illustrated book of Winnipeg views with a brief summary of its wonderful growth.

INTERNATIONAL MACHINE TOOL CO., Indianapolis, Ind. Pasteboard folder containing a graphical comparison between the capacity of a Libby lathe and an ordinary engine lathe.

KERN MACHINE TOOL CO., Cincinnati, Ohio. Leaflet describing this company's 15-inch drilling and tapping machine, containing a brief description with tabulated data of the machine.

WHITMAN & BARNES MFG. CO., Akron, Ohio. Catalogue No. 75 listing the company's entire line of wrenches. Practically every type of forged wrench is included in this pamphlet.

GARVIN MACHINE CO., New York. Circulars Nos. 142 and 143, descriptive of the Garvin vertical-spindle milling machines, and the Garvin No. 3 duplex milling machines, respectively.

NEW YORK REVOLVING PORTABLE ELEVATOR CO., Jersey City, N. J. Bulletin No. 10 showing the use of this company's portable elevator truck, called the "Revolvator", emphasizing its tendency to save time, money and space.

SKINNER CHUCK CO., New Britain, Conn. 1911 price list of this concern. This is a neat little booklet listing the numerous types of chucks manufactured by the company in a convenient form for ready reference.

HEALD MACHINE CO., 20 New Bond St., Worcester, Mass. Treatise on cylinder grinding, by James N. Heald. The advances made from the primitive methods one time employed, are clearly emphasized, and the modern methods of grinding are dealt with in detail.

WARREN WEBSTER & CO., Camden, N. J., have issued a reprint of a paper presented by Wm. G. Snow, chief engineer, before the department of Sanitary Science and Public Health of Cornell University, entitled "Ventilation in its Relation to Health."

SOCIETE ANONYME, DE CONSTRUCTIONS MECANIQUES DE LONGDOZ, Liege, Belgium. The latest catalogue of this firm, which is printed in French, is very completely illustrated, and shows practically every type of machine tool. There is but little descriptive matter in it.

BALDWIN LOCOMOTIVE WORKS, Philadelphia, Pa. Record No. 68 describing the Mallet-type articulated locomotives that have been built by this firm from time to time. A number of typical examples are briefly described, and, in addition, an intefesting summary of the advantages of this type is included.

NATIONAL-ACME MFG. CO., Cleveland, Ohio. The latest production of this firm is a fine example of the printer's art. After a brief summary of the developments that have taken place in the past, a description of the modern automatic machine is given. The title of this booklet is, "The Production of Duplicate Parts."

INTERNATIONAL INSTITUTE OF TECHNICAL BIBLIOGRAPHY, London, England. The first volume of the monthly publications on mechanical engineering abstracts published by this concern. The object of this work is to compile in handy form all articles on engineering subjects, giving the title of the article, by whom, and where it appeared, as well as a very brief abstract of the article.

INGERSOLL-RAND CO., 11 Broadway, New York. Form No. 4602 descriptive of Sergeant rock drills. This rock drill is illustrated in a very clear and comprehensive manner with numerous detail views. Form No. 4109 on the Temple-Ingersoll electric-air rock drill describes that machine in use in different mines. Form No. 3007 is devoted to Class P. B. duplex power-driven air compressors.

BRISTOL CO., Waterbury, Conn. Bulletin No. 130, an illustrated catalogue of this company's electric pyrometer, containing descriptions and lists of both indicating and recording types. A partial list of users is also included. Bulletin No. 152 is a general catalogue of all the different sizes of Bristol's patent belt lacings, containing a number of new illustrations of this style of lacings.

B. F. STURTEVANT CO., Hyde Park, Mass. Bulletin No. 187 of the Sturtevant engineering series, entitled "Economical Fire-Room Methods," which is a reprint of an article from *Power and the Engineer* by F. R. Low. In it the power plant of the American Woolen Co.'s wool-mill at Lawrence, Mass., is described. The article has special reference to the fuel economies and the draft system.

COLBURN MACHINE TOOL CO., Franklin, Pa. Bulletin No. 43, an illustrated pamphlet, devoted to the Colburn 24-inch heavy-duty drill press. The special detail-features emphasized are the automatic tripping device and the compound table. Bulletin No. 44 from this company gives a description of the Colburn floating reamer holder which is adaptable to all vertical boring and drilling machinery.

W. & L. E. GURLEY, Troy, N. Y. This book is the forty-fifth edition of the Gurley Manual of Surveying Instruments, and contains 516 pages, 4½ by 6½ inches. In general get-up it resembles an engineers' hand-book and might be considered as such, applied to surveying. Almost every kind of surveying instrument is included in this remarkable catalogue. It should be of value to civil engineers and surveyors.

BANTAM ANTI-FRICTION CO., Bantam, Conn. Catalogue of ball and roller bearings for all classes of service. The illustrations of the various types of bearings are printed in color, the brass and bronze parts being colored to distinguish the cages and thimbles from the steel ball and roller collars and disks. The dimensions and prices of the various kinds of bearings are concisely given in tabular form. Several new forms of bearings are illustrated.

HILL CLUTCH CO., Cleveland, Ohio. Catalogue on power transmission machinery, bound in cloth, and illustrating a large variety of power transmitting devices with numerous examples of their application. Accompanying tables make the book valuable, not only as a catalogue, but for a reference text-book. Included in the book is the Hill patented collar-oiling bearing, and Smith-type Hill friction clutches, of which special mention is made.

WESTINGHOUSE ELECTRIC & MFG. CO., Pittsburg, Pa. The Westinghouse diary for 1911, accompanied by valuable data on air compression; aluminum; carbon incandescent lamps; heating values of coals; water for condensing; table of dimensions, weights, resistances and carrying capacities of copper wires; steam engines; gas engines; hydraulics; electric locomotives; application of motors to machine tools; electric lighting; railway electrical apparatus; steam turbines; stokers; etc. It also contains information regarding cities, hotels, etc., of value to the traveling man.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4685, "Belt-driven Alternators"; No. 4784, "Electric Drive in Pulp and Paper Mills"; No. 4785, "Electric Drive in Wood-working Plants"; No. 4793, "Steady vs. Unsteady Voltage"; No. 4798, "General Electric Straight Air Brake Equipments"; No. 4804, "Direct-connected Generating Sets"; No. 4807, "Small Plant Alternating-current Switchboard Panels"; No. 4808, "Washington, Baltimore, and Annapolis 1200-volt D. C. Railway"; No. 4809, "4500-volt Oil-Break Switches; No. 4810, Portable and Stationary Air Compressor Sets."

HESS-BRIGHT MFG. CO., Philadelphia, Pa. Catalogue No. 580-A describing the developments of the annular type of ball-bearing. Some of the features treated are: Design and material; plain and ball-bearing characteristics; types of ball-bearings; precisions of manufacture; ball-bearings and automobile construction; annular ball-bearings as applied to line-shaftings; electric appliances, and unlimited field of usefulness; the influence of acid and rust on ball-bearings; and the importance of correct mounting. It also includes much interesting data. This book is more of a treatise than a catalogue, for it is one of the most complete publications on the subject. It is a fine example of the printers' art. Accompanying the book is an indexed folder containing a lot of ball-bearing data boiled down, for ready reference.

TRADE NOTES

PH. BONVILLAIN & E. RONCERAY, Paris, France, were awarded the gold medal, at the Brussels exhibition, which was the highest award for the molding machine department.

NILES-BEMENT-POND CO., and PRATT & WHITNEY CO., announce that W. R. Lathrop is now in charge of their Birmingham, Ala., sales office, in place of N. C. Walpole, resigned.

BAIRD MACHINERY CO., Pittsburg, Pa., dealer in machine tools and machinists' supplies, has opened a branch office in the Masonic Temple Building, Erie, Pa. The office will be in charge of Mr. F. J. McCoy.

RAHN-LARMON CO., Cincinnati, Ohio, maker of engine lathes, is the successor (effective January 1) of Rahn-Carpenter Co. The officers are John Rahn, Jr., president and general manager; and A. J. Larmon, secretary and treasurer.

AMERICAN PULLEY CO., Philadelphia, Pa., announces that it is now carrying at 203 Lafayette St., New York, a large stock of its all-steel "American" split pulleys in sizes ranging from 6 to 60 inches diameter, for the convenience of local dealers and users.

PENTON PUBLISHING CO., Cleveland, O., has removed the Cincinnati office from 11 Blymyer to 808 Provident Bank Bldg. Louis P. Zimmerman is now in charge as representative for the *Iron Trade Review*, *The Foundry*, *The Marine Review*, and *Power Boating*.

NORTHERN ENGINEERING WORKS, Detroit, Mich., reports having installed the following Northern Cranes: Gregg Co., Newburgh, 8-ton, 60-foot; Anderson Forge Co., two 10-ton; Pierce Phosphate Co., 25-ton, 70-foot; Detroit River Tunnel Co., one 25-ton; Pennsylvania Terminal, one 25-ton; Dodge Bros., 10-ton and 15-ton.

FIRTH-STERLING STEEL CO., McKeesport, Pa., announces that the management of its Pittsburg sales office has been placed in the hands of E. S. Jackman & Co., who have been its agents in all the states west of Pennsylvania for the past ten years. This office is under the charge of D. G. Clark. E. S. Jackman & Co. handle Firth-Sterling's products exclusively.

CEMENT AGE CO., New York, announces that *Concrete Engineering* of Cleveland, and *Cement Age* of New York, which are two of the leading monthly publications in the cement field, have been consolidated. Hereafter the two magazines will be united under the title "*Cement Age* with which is combined *Concrete Engineering*." The magazine will be slightly enlarged and an innovation made in the form of a two column make-up.

REMINGTON TYPEWRITER WORKS, Ilion, N. Y., are to be given a largely increased capacity by the erection of a new administration building, which when completed will make all the factory floor space available for manufacturing, and will clear the way for further additions which are being planned. These increases have been occasioned by the pressure of business which has necessitated night work and overtime at the works for some time past.

CINCINNATI BICKFORD TOOL CO., Oakley, Cincinnati, O., has just completed the big undertaking of moving both its shops to the new works at Oakley, which has led to some confusion during the moving process. It is claimed that the new works, when completed, will be the largest in the world devoted exclusively to the manufacture of drilling machinery, and an invitation has been extended by the management to all wishing to inspect the plant.

EDGAR ALLEN & CO., Ltd., Imperial Steel Works, Sheffield, England, whose chief American office and warehouse is at 434 W. Randolph St., Chicago, announce that agency arrangements have just been completed with the following firms at whose warehouses large and comprehensive stocks of Allen's high-speed and carbon tool steels will be carried: Roehm & Davison, Detroit, Mich.; J. L. Osgood, Erie Co. Bank Bldg., Buffalo, N. Y.; and John J. Greer & Co., Inc., 207 W. Pratt St., Baltimore, Md.

LUDW. LOEWE & CO., LTD., Farringdon Road, Clerkenwell, London, E. C., England, is being voluntarily liquidated. The liquidation in no way affects Ludw. Loewe & Co., Ltd., of Berlin, Germany, the English company being independent. The liquidator is Mr. Geo. W. Goodchild who has been acting for upward of five years as managing director. Mr. Goodchild intends to personally continue the business under his own name, on much the same lines as formerly and at the same address.

INGERSOLL-RAND CO., 11 Broadway, New York, has purchased a controlling interest in the A. S. Cameron Steam Pump Works, New York, although the connection cannot be looked upon as a merger. The Cameron works will still continue under the management of

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HAVE YOU A GOOD MEMORY?

About 10 years ago, the first advertisement of the

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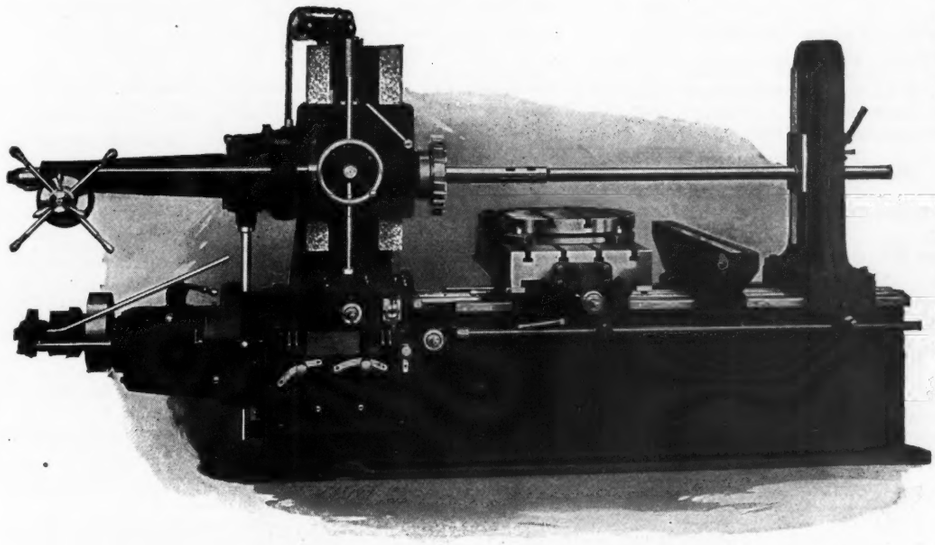

appeared.

Did you see any other LUCAS TYPE machines advertised then?

Do you see much of anything but LUCAS TYPE machines advertised now?

WHY?

MR. TREASURER—February is a Short Month

but your shop can turn out a good month's work if you will buy a

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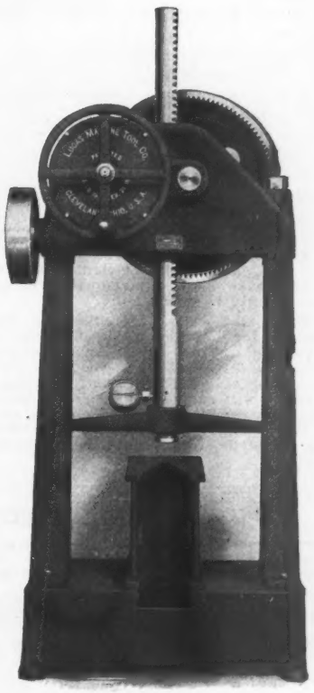

and you can ship a good many DOLLARS' worth in February that will lay over 'til March if you keep on doing your assembling with sledge hammers and hand presses. You can therefore GET YOUR MONEY that much QUICKER and you know what that means.

Lucas Machine Tool Co.

Cleveland, Ohio, U. S. A.

AGENTS—C. W. Burton, Griffiths & Co., London. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao, Barcelona. Schuchardt & Schutte, Berlin, Stockholm, St. Petersburg, Copenhagen. Donauwerk Ernst Krause & Co., Vienna and Budapest. Overall, McCray, Ltd., Sydney, Australia. Andrews & George, Yokohama, Japan. Williams & Wilson, Montreal.

Made in 15, 30 and 50 ton sizes.

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George W. Fuller as in the past, and there will be no change in the policy of the company, except that greater expansion is contemplated. This should make one of the strongest connections of kindred industry that has recently been effected.

CAMMELL LAIRD & Co., Ltd., Sheffield, England, has been awarded the contract for building a Dreadnought battleship for the British Navy that will be the largest and most formidable of any yet constructed. The displacement of the new battleship will be 24,000 tons and the power of her engines not less than 27,000 H. P. The cost of the vessel will exceed $10,000,000. Messrs. Cammell Laird & Co. will build the complete vessel, including the armor plates and armament. The company has a branch store in New York at 34 Cliff St., where a complete stock of high-speed, carbon and automobile steels is carried.

MISCELLANEOUS

Advertisements in this column, 25 cents a line, ten words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

NTS IN EVERY SHOP WANTED to sell my sliding Calipers. eral commission. ERNST G. SMITH, Columbia, Pa.

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EXPERT DESIGNING—IDEAS DEVELOPED by a practical manufacturer. Tool equipment for the manufacture of metal goods a specialty, also power plant arrangement. Best results assured. Lowest prices. Address Lock Box 41, Indianapolis, Ind.

FOREIGN REPRESENTATIVE.—Energetic young man, with mechanical knowledge, and able to correspond in English, wishes the agency, for Belgium, of machines of all kinds, and also of all articles used in machine shops. Pochet, 49 rue du Parc, Liege, Belgium.

FORMULAS AND TABLES FOR SHOP AND DRAFTING ROOM is No. 35 in MACHINERY'S Reference Series, and for practical use in mechanical work is undoubtedly the most widely technical useful book published in years. Send for free pamphlet with new offers. Address MACHINERY, 49 Lafayette St., New York.

FOR SALE.—1 No. 5 Gates Style K, Gyratory Stone Crusher, with geared head elevator and rotary screen. Address inquiries to A. T. Watson, Purchasing Agent, Fairmont & Clarksburg Traction Co., Fairmont, W. Va.

FOR SALE CHEAP.—Complete Mechanical Engineering Correspondence course, Starrett draughtsman's protractor, Mannheim slide rule, and thirty-eight back numbers of MACHINERY, Engineering edition. Frank E. Hall, Chenango Forks, N. Y.

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SEVERAL DRAFTSMEN WANTED.—Applications solicited from men with either ordnance, mechanical-electrical or mechanical-structural experience. State fully age, experience, education and salary expected. Address box 347, care MACHINERY, 49 Lafayette St., New York.

STEEL TEMPERING.—A capable man who has had some experience in treating steel gears and other automobile wearing parts, one who has been used to gas and air furnaces. Address Brewster & Co., Queensboro Bridge Plaza, Long Island City.

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WANTED.—EXPERIENCED GRINDING WHEEL SALESMEN for established territory. To first-class men with ginger and ambition, we offer good salaries and an excellent opportunity of growing up with a company of established reputation. Apply, by mail only, with full particulars (which will be held in confidence) to American Emery Wheel Works, Providence, R. I.

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